COMMON SEASHORE CRABS

Many crabs live on the seashore around our coasts, and five of them are common. They are aggressive fighters, and with their large claws present a menacing sight to any onlooker.

Any part of the shore, from the highest rock pools down to the lowest tide mark among the tangle-weed and kelp (as long as some shelter is available), is a good place to look for crabs.

Common shore crab One of our most familiar and hardy seashore crustaceans is the common shore crab, which you can find all round our coasts. It thrives equally well on rocky shores, sheltered mud flats and salt marsh pools of estuaries (where it is the only crab to live in diluted sea water). When the tide is out, you should be able to find one without much difficulty if you look among rock crevices, in rock pools, or under large stones or bunches of seaweed.

Most crabs have a broad, flattened shell. If you turn a crab over you will be able to see that its small body is folded underneath the shell. The common shore crab is 4cm ($1\frac{1}{2}$in) long and its shell has sharp serrations along its front edge. The shell is usually blackish-green in colour while that of a young crab varies from green to yellow and red, and is often mottled to camouflage it from predators.

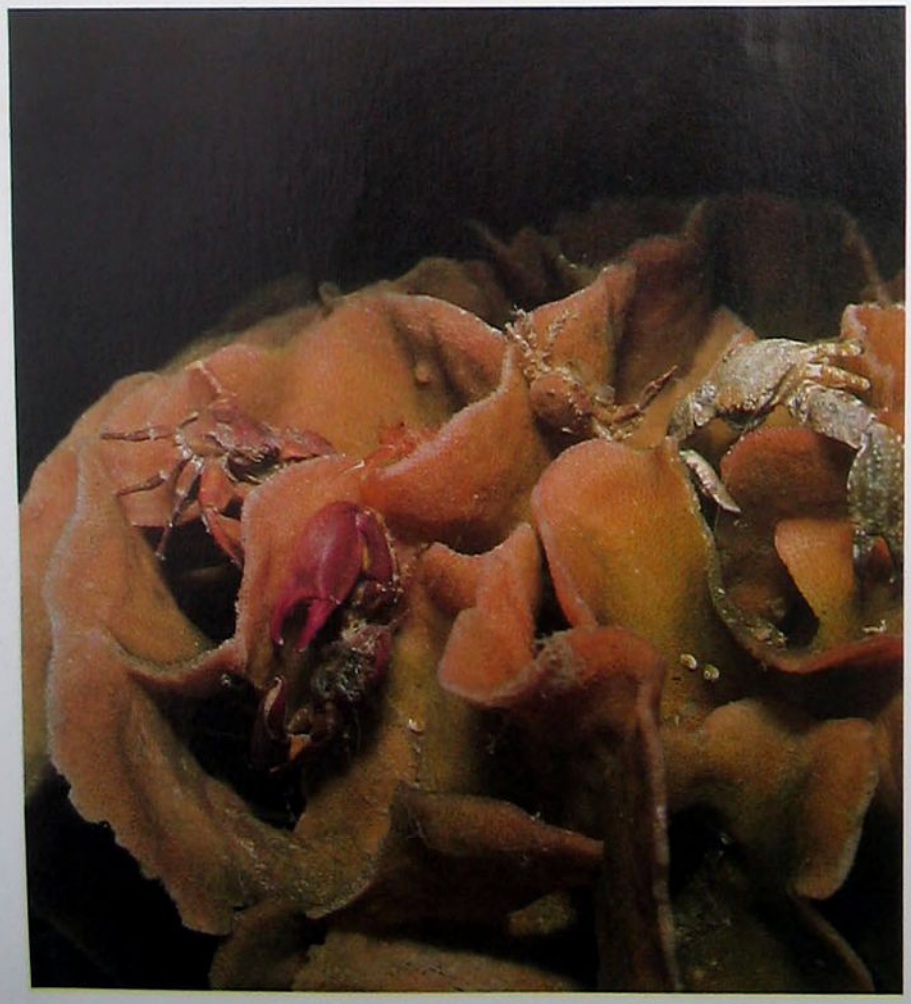
Edible crabs During the summer, you may also find small edible crabs under rocks and in crevices around the low tide mark. These young edible crabs, about 4cm ($1\frac{1}{2}$in) long, are too small, alas, to be eaten; and it is illegal to take them undersized. Older, larger edible crabs, live offshore and reach about 14cm ($5\frac{1}{2}$in) in length. They are caught in crab pots in shallow waters around the coast, usually close to rocks. The edible crab is pinkish or brownish in colour, and its massive claws are tipped with black. The smooth shell with its crinkly front edge also helps to distinguish it from the common shore crab.

Swimming crabs Although swimming crabs have a similar appearance to the related shore crab, you can tell them apart by the shape of their hind legs which are flattened and rounded into paddles for swimming. These crabs normally live in shallow water below the low tide mark, but you can often find the velvet swimming crab under stones and seaweed in rock pools at the bottom of rocky

Above: Shore crabs are pugnacious and tend to live a solitary existence. When they do meet, crabs frequently start to threaten each other by holding their claws in front of their bodies with slightly opened pincers that point downwards. If the threat becomes more serious, the crab holds its claws sideways from the body with its pincers fully opened—as shown by this common shore crab.

Handling crabs
When you search for crabs you can avoid painful nips by picking up shore crabs between your thumb and forefinger across the broadest part of the shell, out of reach of its claws and legs. You would do best to avoid the larger more aggressive swimming crab, because when it is cornered it fights back with its long sharp claws. Look at any you find, but don't remove.

Above: The female velvet swimming crab carries her many thousands of eggs 'in berry'—the characteristic orangy mass that is attached to her underparts. Right: The crab takes only a few minutes to cast off an old shell, but it takes two weeks for the new soft shell to harden. To avoid predators, the crab remains hidden at this time. Below: Several small porcelain crabs shelter in crevices on rose 'coral' or rose-de-mer, found around Guernsey.



shores on our south and west coasts. It is an attractive crab with a reddish-brown shell covered by soft downy hairs. It grows to about double the size of the shore crab.

Porcelain crabs If you look under boulders and stones from the middle of the shore down to the low tide mark, you will probably find one of the small circular porcelain crabs. These brownish crabs are well adapted to life on the shore and their flattened bodies, claws and sharply pointed legs enable them to cling tightly to boulders, thus preventing them from being swept away by the waves.

Two kinds of porcelain crab are found around our coasts; the minute or long-clawed porcelain crab, which is common under stones and on the holdfasts of kelp in clear water, and the less common hairy or broad-clawed porcelain crab. The latter is found under stones in muddy water, where it is partly camouflaged by mud which builds up in the dense fringe of hairs around its claws and legs.

Claw power Shore crabs are active scavengers and eat virtually anything that is edible on the shore. They are also major seashore predators, eating small invertebrates such as ragworms. Larger shore crabs and edible crabs feed on shellfish and the powerful crushing claws of the edible crab can crack open fairly large shells which it digs from depths of up to 20cm (8in). These heavily armoured crabs are restricted to slow-moving prey.

The rapid snapping movements of the claws of the lightly built swimming crabs enable them to catch faster moving prey such as small fish. Swimming crabs have been seen to chip gradually away at the opening of a topshell until they expose the snail inside and eat it. Porcelain crabs use a totally different method of feeding, filtering fine particles of food from the sea water using a net formed by fringes of hairs attached to their mouthparts.

Tidal cycles When you find crabs at low tide they are usually resting, because they search for food only when they are submerged by the tide, being most active at night. When the tide is out, crabs hide away under

Five common shore crabs

Right: **Hairy or broad-clawed porcelain crab** (*Porcellana platycheles*), 12mm long.

Left: **Minute or long-clawed porcelain crab** (*Porcellana longicornis*), 6mm ($\frac{1}{6}$in) long.

boulders and crevices.

The times when they are on the move depend largely on such natural rhythms of the shore as the tides, the cycle of day and night, and the seasons. During the winter months, for instance, larger shore crabs, particularly the estuarine species, are less easy to find because they move out to offshore waters. Edible crabs also move into deeper water during the winter months, so you are unlikely to find them on the shore then.

Eggs and larvae In early spring you may notice female shore crabs carrying masses of orange eggs underneath their bodies; at this time they are said to be 'in berry'. Each mass contains thousands of tiny eggs–in the case of the edible crab up to three million–which hatch in late spring and summer as small shrimp-like larvae, known as 'zoea'.

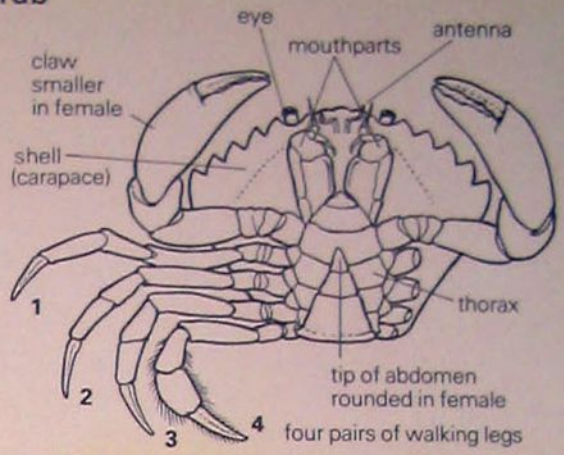
Sometimes you may confuse the egg masses of the shore crab with a small yellow parasite, a relative of the barnacle, which attaches itself to the crab in a similar place under the body.

The zoea larvae develop in the water as part of the plankton and have long spines which keep them afloat. After several moults the larva is transformed into a fully formed tiny crab which then settles on the shore.

Growing by moults As the young crab increases in size, it outgrows its rigid protective shell and has to replace it several times by moulting. In order to moult, the crab takes in water, its body swells and the old shell splits along the underside. The crab then withdraws rapidly from the cast shell revealing a new, soft shell underneath. After about ten such moults, the crab reaches its full size and after this the adult crab moults only once a year. Adult males moult in late winter and females in autumn just before mating. You may possibly find a male covering the female with its body to protect her until her shell hardens again. This is not just an act of chivalry: they only mate while the female's shell is soft. Males grow to a larger size and have larger claws than the females. It is difficult to tell the age of crabs but large male shore crabs may live for up to four years, while edible crabs can reach ages of 15 to 20 years.

Anatomy of a crab

Females have smaller claws than males, and the abdomen has a rounded tip with two more segments, in order to accommodate the eggs.



Autotomy

Crabs can shed a limb voluntarily, by snapping it off through a sudden muscle contraction at a breaking point near the base of the second limb segment (left). A membrane covering the broken surfaces reduces damage and bleeding. The limb grows again at moulting although it does not reach full size until after several moults.

Shedding a limb Despite their armour, crabs have many enemies such as seabirds and large fish, so the ability to cast off a trapped limb (autotomy) can be a life-saver. It is equally useful in the many skirmishes that occur, especially between male crabs.

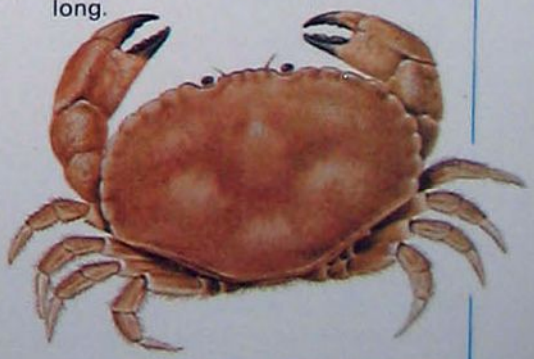
Autotomy also comes in handy if a crab gets trapped between boulders. Its leg joints are connected in such a way that a crab frequently finds it difficult to manoeuvre out of such a position. This is also the reason why you see crabs scurry and dart in a curious sideways fashion–their leg joints allow them movement in one direction only.

Other coastal crabs will be featured later.

Below: **Common shore crab** (*Carcinus maenus*), 4cm (1½in) long.

Above: **Velvet swimming crab** (*Macropipus puber*), 8cm (3¼in) in length.

Below: **Edible crab** (*Cancer pagurus*), 4cm (1½in) long, 1½ times wider. Offshore variety 14cm (5½in) long.



PRIMITIVE HORSETAILS

The sturdy but graceful horsetails you see growing in damp parts of Britain today are the few remaining relatives of giant horsetail trees that once thrived in ancient forests.

Horsetails are among the most primitive of land plants. They probably arrived on earth at the same time as clubmosses and giant ferns some 3-400 million years ago, and were one of the first groups of plants to evolve an internal tube or vascular system to transport nutrients and water around the plant, as well as strong stems for the support needed for a life out of water.

They were most common during the Carboniferous Period, 280-340 million years ago, when they formed dense swamp forests. The ancient giant horsetails grew up to 30m (100ft) tall and had thick woody trunks. Eventually these luxuriant forests became buried and compressed under later deposits of rock and formed some of the coal deposits that are mined today.

The horsetails you see today lack the stature of their giant ancestors, but are still more or less confined to wet ground, (whereas the highly successful flowering plants that appeared about 180 million years ago have evolved to conquer even the driest habitats).

Today there are about 25 species of horsetails in the world, and only seven grow in the British Isles. Of these, three species are widely distributed throughout our islands–the marsh horsetail, the water horsetail and the common horsetail. You sometimes see them beside railway lines or on nearby allotments, and they are also common on the asphalt of tennis courts.

Above: **Great horsetail** (*Equisetum telmateia*) is common throughout all parts of the British Isles apart from north-eastern Scotland. It grows best in damp shady woods and hedgerows and is easy to spot for its whorls of slender drooping branches which occur at regular intervals on its white woody jointed stem. Ht 150cm (5ft).

Massive root structure Horsetails possess a large underground rootstock or rhizome from which an extensive root system spreads out into the soil for several metres, penetrating downwards to a depth of 2m (7ft). In spring the shoots emerge with their characteristic jointed stems. The stems are hollow, except at the solid joints (nodes). The stem surface of each species is marked with a different pattern of vertical ridges and furrows.

The upper end of each section of the stem is crowned by a sheath of long pointed teeth into which the end of the next section fits. Each sheath is really a ring of tiny leaves which do not function as true leaves because they contain no green pigment (chlorophyll).

Photosynthesis is carried out solely by the stem and the whorls of side branches. In most species whorls of jointed side branches radiate from just below the leaf-sheath. Each branch is constructed exactly like the main stem, but it is solid rather than hollow.

The spore-producing cones (strobili) are borne on the stem tips in most species but the common horsetail differs in that it produces a separate unbranched 'fertile' stem. This is a pale brown colour, containing no chlorophyll, so the plant depends on the green sterile stems for nourishment. The egg-shaped cones are packed with spore capsules which ripen during summer. When they have shed their spores, the green shoots develop, bearing the familiar whorls of branches.

Reproduction Although horsetails belong to a plant group all of their own, their closest allies are ferns which have a similar reproductive system (see page 265). Clouds of dust-like spores are wafted away by the wind and those that land on a suitable place quickly germinate into a tiny leafy structure called a thallus. The male sex organs (antheridia) and female sex organs (archegonia) are borne on the underside of the thallus.

At the point of sperm release horsetails are completely dependent on the presence of moisture because the male sperms must swim through a film of water to seek out the eggs in the archegonia. After fertilisation the eggs grow into the familiar spore-producing plants.

An interesting feature of horsetails is their ability to absorb large amounts of silica from the soil and deposit it in their stems and branches. Sand, and also glass, is made mostly of silica, and thus it gives the plants a distinctly gritty, brittle feel which is rough to the hand, rather like sandpaper.

In medieval times horsetails were used to give metal, wood and bone a final polish when a high gloss finish was required in ornamental work. The Dutch rush (*Equisetum hyemale*), in fact a species of horsetail although it is unbranched, was imported in large quantities from Holland, and used as a natural scourer for pots and pans. Horsetails were often known as scouring rushes because their gritty texture made them extremely useful domestically before modern cleaning methods.

Above: **Water horsetail** (*Equisetum fluviatile*) grows well in shallow water in ponds, ditches and lakes but is less common in marshes and fens.
Ht 100cm (39in).

Inside a common horsetail

scale leaves
conducting tissues
stem cavity– between each node the stem is hollow
node– at each node the stem is solid
stem composed of ridges and furrows

Left: **Common horsetail** (*Equisetum arvense*) is common in fields, hedgerows and waste places, and is often a troublesome weed. The cones in this picture are almost ready to shed their spores.
Ht 50cm (20in).

HEDGEHOG TALES: FACT OR FICTION?

Hedgehogs live a generally quiet and unobtrusive life. So it comes as a surprise to find them performing like exhibitionists—running round in circles or twisting into strange contortions to cover their spines with a mass of frothy saliva.

Above: Self-anointing is one aspect of strange hedgehog behaviour which is known to take place. However, its purpose is still a complete mystery. The hedgehog produces a mass of frothy saliva which it spreads over its spines.

Most of the hedgehog's life is conducted under cover of darkness. Consequently we know relatively little about the details of its behaviour. People who put out food for hedgehogs soon discover that their visitors have a 'pecking order' of seniority; 'top' animals being very ready to attack and chase off subordinates. However, under natural circumstances, where food is more dispersed, the hedgehogs are too. They meet each other comparatively rarely.

Communication between hedgehogs is limited to an occasional quiet muttering noise, and loud snorting when a male courts a female. They have also been known to emit a wild scream, like a squealing pig, but only when severely frightened. Smell and scent are probably quite important, but this aspect of hedgehog behaviour has not yet been systematically studied.

Unexpected agility Considering its generally quiet and undramatic existence, some aspects of the hedgehog's behaviour seem surprisingly out of character. For example, who would believe that such a small, tubby creature should be an expert climber? Yet hedgehogs easily scale garden fences, and have been known to climb up ivy into first-floor windows, and to hibernate in roof thatch.

Hedgehogs can swim, too. But although there have been reports of them crossing rivers and streams with ease, they seem to drown in small shallow ponds all too frequently. Plastic-lined garden ponds are a special danger because it is difficult for hedgehogs to climb up their sheer, slippery sides. Hedgehogs also fall into things, with monotonous regularity. Cattle grids, for example, claim numerous victims. This suggests that wandering hedgehogs are either curious or careless.

Self-anointing In view of the hedgehog's normally undemonstrative behaviour it is astonishing to watch one in the process of self-anointing. This energetic and messy procedure would seem strange enacted by any animal; but the contortions involved might make it seem impossible for a hedgehog. Self-anointing consists of producing large quantities of frothy saliva, like soap suds, then spreading it over the spines and flanks, using the tongue. The animal twists and writhes, bends its head right back over its shoulders and often rears up, lifting one or other foreleg completely off the ground. Its pink tongue is much longer than you might expect and is thrust out to flick spit to the furthest extremities of the body.

During the course of this exercise, the animal is totally engrossed in what it is doing and takes no notice even of a camera and flashgun. So much effort and concentration goes into its performance that the hedgehog sometimes just falls over, but even this is only a minor interruption.

The whole procedure is reminiscent of exaggerated washing behaviour, but seems unlikely to be related to keeping clean. No attempt is made to use the feet to help (as is normal in rodent toilet behaviour, for example) and rarely is any attention paid to the belly fur. Moreover, dirty and flea-ridden hedgehogs show no greater inclination to self-anoint than usual; and conversely, perfectly clean pet hedgehogs often anoint with great frequency and regularity.

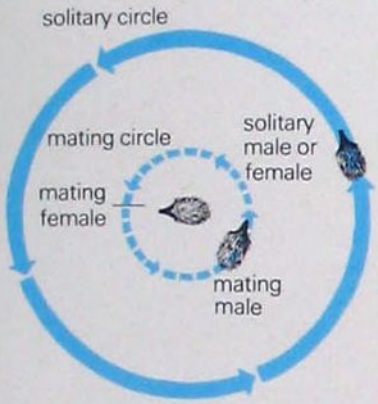
What could be the purpose of this extraordinary behaviour? One of the more plausible ideas recently put forward is that it is a form of self-protection against predators such

Left: Hedgehogs are not renowned for their intelligence. In captivity, they rarely learn to do more than come when called to food. In the wild, they often meet with fatal accidents, falling into ponds and down cattle grids.

Apple gathering

For centuries, people have claimed that hedgehogs deliberately roll on apples so that the fruit becomes impaled on the spines and can be carried off to be stored or eaten. The story is so prevalent and is often attributed to such trustworthy sources that it would be rash to dismiss it as a fairy tale.

Below: Hedgehog circles are another curious and unexplained phenomenon. The hedgehog runs round a set course every night, for up to two hours at one stretch, at a speed of over 4mph. Observations have shown that the animal persists in this behaviour for up to a month at a time, except on rainy nights. Circling is also a prelude to mating, but in this case the circle is much smaller, only 60cm (2ft) in diameter instead of about 14m (45ft). The male circles the female, while she remains on one spot.



Below: Hedgehogs lead rather solitary lives, coming together only for mating. The male takes no part in rearing the young, but the female has the company of her litter for about five weeks until they are weaned. The young then disperse to live on their own.

as foxes and badgers. Anointing often begins with chewing things, to stimulate the production of the frothy saliva. Toad skin is a particularly effective trigger, and toads have poisonous skin secretions. Perhaps the hedgehog chews a dead toad and then spreads the poisonous substance over its spines as an added deterrent. However, hedgehog spines are an effective protection without this embellishment and most self-anointing sessions do not involve toads.

Sadly, the mystery is not that easily solved. It is true that sharp-tasting things often start off the salivation, but some hedgehogs begin with practically no encouragement. Another possible explanation is that the hedgehogs use this method to cover themselves with distinctive scent. Many other mammals have well developed skin glands which contribute to individual smell; maybe hedgehogs have scented saliva? To us it may not smell much, but who knows what other hedgehogs make of it? Certainly pigs can secrete a sex-related scent into their saliva; why should hedgehogs not do so too? One problem with this theory is that scent secretion is normally associated with adult animals and is especially strongly developed in breeding males; but self-anointing in hedgehogs is found in both sexes and in young less than a month old.

Carrying apples Extraordinary though it is, self-anointing is not the only bizarre piece of behaviour attributed to the hedgehog. Since Roman times, people have claimed that hedgehogs roll on apples to attach them to their spines. Such a long-standing theory, however unlikely, cannot be dismissed without careful examination.

It is certainly possible for a hedgehog to carry apples on its spines–if you put them there first. However, it requires quite a strong thrust to poke the spines through tough apple skin and it is hard to see how a hedgehog could arrange to do this for itself. It would be easier with softer smaller fruit like grapes or strawberries; the hedgehog could roll on these and spike several at once. In fact, this is a version of the story which is told in China and also in Spain; but here in Britain, apples are almost always the alleged booty. Maybe soft, rotten apples are used?

The main problem with this story is why a hedgehog would want to collect fruit in the first place. The obvious explanation would be that the hedgehog stores away fruit for the winter, as a reserve food supply during hibernation. Some rodents do this (squirrels and bank voles, for example), but not hedgehogs. Their winter nests never contain stored food; all their reserves are laid down as fat within the animal's own body. So, if the fruits are not being stored, why not eat them where they are found? Hedgehogs certainly eat fruit (although probably not in large quantities), but they do not need to carry it about.

Milk thieves? There are similar credibility problems with another very old tale of hedgehog behaviour–that they suck milk from cows. It is true that hedgehogs like milk. It is also true that they are frequently found in cow fields, although this may simply be due to the attractions of worms and dung beetles. The obvious objection to this story is that the hedgehog is not tall enough to reach the cow's teats. However, this difficulty is removed as soon as the cow lies down; in this position, milk tends to ooze from an overfull udder and could easily be lapped up by a foraging hedgehog.

Anyone who sees a milk-lapping hedgehog by the udder of a cow could be forgiven for saying that the hedgehog was sucking milk from a cow; maybe the story has such an origin. It seems unlikely to be literally true, because the hedgehog has a relatively small mouth for such big teats and the cow would probably object to the hedgehog's sharp teeth and jerk sharply away. Not long ago, however, a report was published in a veterinary journal which attributed injuries observed in a cow to precisely this sort of event.

Milk-sucking and apple-carrying are surely no more incredible than self-anointing. Since we know that self-anointing certainly takes place, perhaps we should not scoff at the other tales of hedgehog behaviour just because they seem improbable or occur in books hundreds of years old. Perhaps, too, we should pay attention to the more recent stories of hedgehogs rushing round and round in circles.

In this case, the disturbing thing is precisely that circling is *not* a centuries-old observation that turns up in all the old natural history books. Could this highly peculiar and distinctive behaviour be a modern addition to the hedgehog's repertoire? Could it perhaps be caused by hedgehogs eating one of the many poisons, fertilisers or other chemicals that we scatter about our farms and gardens in the belief that they are 'safe'?

The hedgehog may be an unobtrusive animal which lacks the complex behaviour patterns of some other mammals. But its occasionally bizarre antics easily compensate for the interest lacking in its day to day existence.

EGGS OF ALL SHAPES AND SIZES

Eggs come in a splendid variety of shapes, sizes, colours, markings and clutch numbers – each adapted to meet specific survival needs. Egg-laying and incubation are equally varied.

Over the years collectors have stored the shells of eggs in cabinets for their marvellously varied colours. For some years now this activity has been illegal for almost all species. Despite this, undercover egg-collecting still continues, which is all the more tragic when you consider the fascination that the live egg offers.

Development of the shell During the egg's time in the female's oviduct a watery jelly egg-white (albumen) is deposited around the yolk. The albumen is itself surrounded by two soft, but relatively strong membranes, and finally by successive thin layers of a chalky (calcareous) deposit. These harden to form the protective shell. The two membranes both lie very close to the shell except at its broadest end where an air pocket, from which the hatching chick will eventually draw its first breaths, separates them.

The hard, porous shell is designed to protect the egg's contents from injury; the pores allow the passage of air for the developing embryo, but prevent the intrusion of water and other liquids, as well as the evaporation of the egg's liquid contents.

Egg-laying intervals Unevenly shaped eggs are often laid broad-end first, however painful that may seem; but evidence suggests that some birds lay theirs pointed-end first. Birds of many species lay eggs at daily intervals, usually early in the morning, until the final complement of eggs in the nest (clutch) is complete. In these cases incubation of the eggs by the parent begins when all, or almost all the eggs are laid. The result is that the nestlings are roughly the same size when they hatch, and are able to compete on equal terms with each other for the food brought by their parents, which is normally in plentiful supply.

However, some birds at the top of food pyramids, such as the tawny owl (see page 14), the kestrel (see page 92) and the heron lay their eggs at two day intervals, or even longer, and may begin incubation as soon as the first or second egg is laid. So, when all the young have hatched they are of unequal age and size. The apparent reason for this is that the birds have adapted their egg-laying to a variable and uncertain food supply.

In breeding seasons when there is a food shortage, only the oldest nestlings are strong enough to secure a sufficient share of the available food to fledge successfully, and the youngest die. If they were all the same size in times of food scarcity, then all would be in danger either of starving, or fledging in too weak a condition to survive the hazardous first few months of life on their own. In seasons when food is abundant, all the nestlings may fledge successfully. Conversely, if there is a dramatic drop in the food supply the parent bird may not breed at all.

How birds incubate The female, together with the male in some species, incubates the eggs by sitting on them and warming them with its body heat. This stimulates the embryo to grow. Many species have a feather-free area under their bodies, known as a brood patch. This patch allows the eggs direct contact with bare skin through which the incubating bird transfers heat from well-developed blood vessels. In those birds where incubation is shared by the sexes, such as the avocet (see page 415), the males may also have brood patches. Other species, including the gannet, use their fleshy feet to incubate eggs and therefore lack brood patches.

Incubation periods vary considerably according to the species. It takes 10 to 14 days for the eggs of most perching birds (passerines) to hatch, but rooks and other crows, for instance, take up to 19 days. Herons, ducks,

Many waders, such as the avocet and the lapwing (above), lay relatively large, pear-shaped eggs which do not roll away from the nest on the ground when left unattended. Usually four eggs are laid. The incubating parent arranges them so that the pointed ends are turned to the middle of the nest; this makes it easier to sit on them, and even less likely that they will roll away. Notice the 'egg-tooth' on the chick: this is a small extension on the upper bill which the developing bird uses to break out of the egg. It falls off shortly afterwards.

Above: The large, elongated pear-shaped egg of the guillemot would be easily blown off the bare cliff ledge on which it is laid—were it not for its shape, which causes it to roll round in a tight circle on its axis. Right: Grebes often cover their white eggs with decaying waterweed and this, together with the mud, stains them brown. So on shallow flats, where the eggs are exposed to view in the open nest, some camouflage is achieved.

auks and some birds of prey take 25 days, while gannets take 40 days, and petrels, including the fulmar and Manx shearwater, incubate for as long as 50 days.

You can sometimes spot an incubating bird turning the eggs: such behaviour is believed to ensure that the eggs receive an even amount of warmth; they are also positioned to make it easy for the young birds to hatch.

On the whole, those young birds which are most developed on hatching belong to species which have fairly long incubation periods. Thus newly hatched ducklings are active, covered in down and able to feed themselves right away; while passerine nestlings, which hatch after relatively short periods of incubation, are naked, blind, utterly helpless and entirely dependent upon their parents for food.

Emergence from the egg Whether the chicks inside the egg are downy or naked, they escape from the egg-shell either by chipping out a small hole or a line of weakness in it (depending upon the species) with an 'egg-tooth'–a small protruberance on the upper mandible which falls off afterwards. The break-out is completed by a series of convulsive stretching movements. The broken egg-shells, which could attract the unwelcome attention of predators, are then usually removed by the parents and dropped at a safe distance.

Clutch-sizes It is difficult to discover precisely what factors determine the characteristic clutch-sizes of different species. In those species whose young are hatched in a helpless condition and have to be fed by the parents, not only to the point of fledging but for some time afterwards, it seems obvious that the time and energy available for collecting sufficient food is crucial. Thus within these limits the parents rear the largest number of young for which they can provide adequate food, and the clutch-size has become adjusted accordingly. This is borne out by the fact that within particular species clutch-size tends to increase the further north the birds are because there are more daylight hours for the birds to collect food.

In some species with helpless young, such as tits and short-eared owls, the clutch-size

Development within the egg

When freshly laid **(1)** the fertilised egg of a grey partridge (left) has already begun to develop. By the third day **(2)** the main blood vessels are visible. A week later the network of blood vessels is advanced **(3)** and the chick's eyes and legs are evident. Close to hatching **(4)** the chick begins to twist round. Right: The little tern is conspicuous against its open sandy nest, so it leaves its well-camouflaged eggs to avoid the gaze of predators.

can nevertheless vary from year to year, or location to location, according to fluctuations in their chief sources of food. Birds such as ducks and game-birds, whose offspring are more or less capable of fending for themselves on hatching, often lay very large clutches because the parents do not have to collect food for them. Of course, the ability of a sitting bird to cover the eggs in its nest comfortably is, in itself, an additional limiting factor, and probably influences egg-size too. It could also have something to do with the bird knowing when it has laid enough eggs; though precisely how it knows when to stop is not yet understood. Certainly more eggs are produced within the female's ovary than are required, but they are re-absorbed once the requisite clutch has been laid.

Eggs that suit the nest Birds' eggs vary in shape between the species as well as in size. The egg-shape is generally related to the type of nest or nest-site. The guillemot's eggs are pear shaped, an adaptation which prevents them falling off their precarious cliff ledge and smashing hundreds of feet below. The pear-shaped eggs of waders, and other birds which nest in a scrape in the ground, helps prevent them rolling away if left unguarded. The eggs of those birds which build cup-shaped nests, such as many song birds, or nest in holes or similar secure places, such as puffins, are often oval or spherical in shape as they are in no danger of rolling away.

Colours, spots and blotches The first birds' eggs were white like those of their distant reptilian ancestors, and many birds today still lay white eggs–the petrels, ducks, owls and woodpeckers in particular. In those species which nest in holes or burrows the white eggs are more easily seen in the darkness by the incubating bird and thus less likely to be broken.

Coloration (pigmentation) appears to have evolved in response to a need to protect the eggs from the prying eyes of predators. The pigments are deposited during the later stages of the formation of the shell in the oviduct. While basically similar, tints and markings show a good deal of individual variation both within the species and between eggs laid by the same female.

The eggs of species which lay in open nests or scrapes on the ground are marvellously and effectively camouflaged. Sometimes, as in the little tern for instance, they are almost indistinguishable from their surroundings. It may be difficult to understand what protection is achieved by the brightly coloured and conspicuously marked eggs of some song-birds, such as the song thrush or yellowhammer; but here it seems that the effect is disruptive: breaking up the outline of the eggs sufficiently, especially in the constantly moving, dappled sunshine and shadow thrown by the adjacent vegetation, to deceive the eyes of a less perceptive intruder. Such patterns also help birds in colonies recognise their own eggs.

Left: The tufted duck lays its dozen or so greenish-grey eggs in a depression in a grass tussock, hidden from any predator's view. Ducks' eggs are normally oval, but they cannot roll out of their nests which are cup-shaped. After the chicks have hatched the broken egg-shells are left in the nest. This is unusual, as most birds hide them to avoid predators.

Above: The chaffinch's eggs are bluish-white with red wine-coloured blotches. Four to five is the normal clutch. These eggs are well concealed and protected by the cup-shaped nest of lichens, moss and spiders' webs.
Right: The clutch of a song thrush's bright blue eggs, spotted with black, and nestled in a smooth mud cup of the compactly constructed nest, seem surprisingly poorly camouflaged against the mottled green and browns of the foliage.

THE APHID: PLANT-PEST

Everyone who grows roses is familiar with the havoc caused by aphids. These tiny insects infest the growing tips of plants and pierce the living tissue with their tube-like mouthparts to suck the sap.

Aphids, also known as greenflies, blackflies and plant lice, belong to the Homoptera or similar-winged insect group. They are soft-bodied insects, a few millimetres long at the most, and often occur in vast numbers on delicate broad bean shoots, the tips of rose bushes or the underside of rather sickly-looking currant leaves.

There are several hundred species of aphid in the British Isles, many of which live on wild plants and do no damage to our crops. Those that live on cultivated plants, however, do serious damage. Aphids feed on the sap in plant tissue, piercing leaves, shoots, stems and sometimes roots with their tube-like mouthparts. They usually go for the growing tips which are the most easily penetrated and succulent parts of the plant. Under a severe aphid attack, plants wither and soon die.

The success of aphids is due largely to their extraordinarily high rate of reproduction, which makes up for big losses due to predators and parasites. It is aided by their simple three-stage life cycle, there being no pupal, or resting, stage. However, the life cycle is complicated by the fact that a species can appear in a number of different forms (this is known as polymorphism): winged males, wingless sexual females, and winged and wingless parthenogenetic females. (Parthenogenesis is reproduction without fertilisation by a male.) The different forms of female can either give birth to live young (viviparity) or lay eggs (oviparity). Polymorphism also enables many species of aphid to live on more than one host-plant. Many species have at least one winter and one summer host.

The black bean aphid, a common species everywhere, has a life cycle that is typical of many aphids (the details differ from species to species). Its winter or primary host-plant is usually the spindle bush, but introduced shrubs such as guelder rose and mock orange are favoured as well. In late summer the aphid lays small, shiny, elongated, black eggs, usually singly, in the axil of a leaf bud or small twig on the host-plant. They overwinter in this stage.

The eggs hatch the following spring into wingless females called stem-mothers. These are parthenogenetic females which, when mature, bear live young—more parthenogenetic females, but with developing wings. The winged females leave the colony and fly to the summer host plants—broad bean, spinach, sugar beet or docks—to feed. As the weather becomes warmer and the number of daylight hours increases, several more winged and wingless generations are produced, the winged forms spreading the colonies further and further afield.

Towards the end of summer, the winged female aphids migrate to the winter host-plant. They, the winged parthenogenetic females, now produce wingless but sexual

Rose aphids (*Macrosiphum rosae*); at about 5mm ($\frac{1}{5}$in) long, these are among the largest of our several hundred different species of aphid. Rose aphids are confined, as their name suggests, to one type of host plant—wild and cultivated roses—and are extremely destructive. Where you see many aphids you often also find one of their greatest enemies, the ladybird (above). This insect is an avid eater of aphids, both in its larval and adult form. There can be considerable variation in the colour of adult aphids (left), although pink and green, with black spots, predominate. The cornicles are black and the eyes are red. The two pairs of wings, when present, have a kind of mother-of-pearl lustre on them. Like those of other aphids, the wings of the rose aphid are rather delicate and have a dark main vein running near the front edge, with four smaller veins branching off it, one of which branches again about half way down.

females. Winged males, produced by wingless parthenogenetic females on the summer host-plants, then fly to the winter host-plant to mate with the sexual females. The sexual females lay their eggs on the winter host-plant. These overwinter and hatch the following spring.

Other aphid pests The rose aphid is the best-known of aphid pests (see caption, page 492).

The cabbage aphid (*Brevicoryne brassicae*) restricts itself to brassicas such as brussels sprouts, kale and broccoli, producing malformation of the flower buds and a discoloured blistering on the leaves in summer.

The woolly aphid (*Eriosoma lanigerum*) is another common species with only one host-plant (that is, in Britain). The female overwinters in a crevice in the bark of an apple tree, occasionally migrating down to the roots of the tree. The copious exudation of 'woolly' wax shelters many individuals.

The currant blister aphid (*Cryptomyzus ribis*) causes discoloration of the leaves of currant bushes in early summer, before migrating to various plants of the dead-nettle family. Like the black bean aphid on spindle, the females lay eggs on the woody stems of currant bushes.

One species, the potato aphid (*Myzus persicae*), is a transmitter of a virus disease, leaf roll, that can considerably reduce the potato crop of a field. Since this species cannot normally exist in an upland climate, seed potatoes grown in Scotland and other upland areas are usually free of the virus. The primary winter host of the potato aphid is peach, but since this tree is infrequently grown in Britain, the aphid has taken to overwintering on brassica crops.

Wax and honeydew Most aphids have a conspicuous pair of cornicles, or tubes, looking like long car exhaust pipes, projecting backwards from near the rear end of the abdomen. From these exudes a waxy substance which appears to give the aphid some protection against desiccation, and perhaps against certain predators. It is supplemented by a waxy secretion from glands distributed over the skin. In some species, such as the woolly aphid, the whole insect is buried beneath wool-like (flocculent) tufts of white wax. This seems to give some protection against the tiny parasitic braconid wasp which lays eggs in the bodies of aphids.

The other fluid produced by aphids is honeydew – the sticky-sweet substance that is often such a nuisance to motorists who park their cars under trees in summer. Honeydew, a sugar-rich fluid emitted from the end of the aphid's gut, is the excess plant sap which the insect must imbibe in order to get enough solid fluid for its needs. The honeydew attracts ants which 'farm' and 'milk' the aphids.

Predators Ladybirds and their larvae, and the larvae of lacewing flies and hoverflies all prey on aphids, as do many birds.

Above: Black bean aphids (*Aphis fabae*); these are also known as black blight and blackfly. In summer their host-plant is broad bean, sugar beet, spinach and docks.
Left: An aphid giving birth to live offspring. At this stage of the life cycle, the female aphid reproduces parthenogenetically (without being fertilised).
Below: Woolly aphids hidden within the fluffy white 'wool' – a wax-like substance secreted from the cornicles.

HEATHER MIXTURE

By late summer and early autumn many moorland areas in the British Isles are aglow with a patchwork of flowering heather and heaths in glorious shades of deep pink and purple.

The best known species of the heather family is the true heather (*Calluna vulgaris*), or ling as it is often known. Along with several other British species of heaths, it belongs to the Ericaceae family which has more than 1350 species scattered throughout the world. Ling and heaths are similar in size and colour, they thrive in the same conditions and often bloom at the same time of year. Many people refer to ling and heaths as heather.

Ling is common throughout the British Isles. It is a robust evergreen species of bogs, moors, open woods, sandy heathland and highlands up to 700m (2400ft), and it thrives particularly on well-drained soils. It does not grow much taller than a metre (3ft), its pliable,

Above: Bell-heather, flowering with ling. The two species are commonly found growing together on heaths and moors with acid soils.

Right: Bell-heather flowers have small sepals and brightly coloured bell-shaped flowers clustered towards the tips of the stems. Bell-heather blooms from July to September.
Ht 60cm (24in).

Above: A large marsh grasshopper on cross-leaved heath. The edge of the leaf is folded backwards to reduce water loss by evaporation. This species flowers from July-September.
Ht 60cm (24in).

Right: The flowers of cross-leaved heath are clustered together at the tip of the stems. They are usually pollinated by small insects but they may also be self-pollinated.

tough woody stems becoming twisted and tangled around one another as it sprawls across the ground.

The pairs of short, stalkless green leaves, arising directly from the stem, have two projections at their base. Those that grow from the short side stems are close together and often overlapping, while those on the main stem are more spaced out.

Heather comes into flower in mid July and may continue until the end of September. The pale purple flowers are solitary, either on the main stem or on lateral branches. They are rounded in appearance and have four tiny sepal-like structures at their bases. The pale purple stigma and style of the female parts protrude from the centre of each flower. After fertilisation the flowers lose their colour and form dark brown capsules which are easily detached in the wind. White forms of heather occur sporadically in the wild and are much favoured by collectors and gypsies as they are supposed to bring good luck.

Nectar pots Heather flowers are prolific producers of nectar and are much sought after by bees. Each flower has eight nectaries which are arranged alternately with the stamens. As the plant matures the nectar flow diminishes, but other factors such as the nature of the soil and the subsoil, the age of the plant, the amount of rainfall and the altitude, all influence the nectar flow.

Dark heather honey is highly regarded. It commands a good price partly because it makes thick honey which has to be squeezed from the comb by pressing, thus destroying the valuable wax comb. Dark honeys have on average ten times more minerals in them than light honey, so some people claim they are a better health food than light honey. Beekeepers often move their bees to heather areas such as Ashdown Forest, the New Forest and the north Yorkshire moors. It is a general belief that beekeepers get bumper crops of heather honey once every seven years.

Heather provides cover and food for a number of birds and insects. The Scottish heather moors give ideal cover for the famous red grouse which feed on the tender young heather shoots; small heather beetles are found deep in the foliage; and the green larvae of a particularly spectacular moth, the emperor, feeds on heather in June, July and August – you can recognise them by the distinctive black markings on their bright green bodies, with blackish bristles arising from warts along their length.

Heaths Six native heaths are found in the British Isles. Two of the most common species grow throughout the country, in similar conditions to ling, to an altitude of 700m (2300ft): the bell-heather, (*Erica cinerea*), sometimes known as purple bell-heather or Scottish heather, also occurs on heaths and moors with true heather; it tends to grow in drier areas than its close relative the cross-leaved heath (*E. tetralix*).

Both species grow as shrubs up to 60cm (24in) high. Bell-heather is a straggling species that is characteristically found on dryish areas that are often surrounded by bogs. It flowers earlier than true heather, with deeper purple, much larger, distinct bell-shaped flowers. The flowers are borne in groups towards the tip of the stem at the base of clusters of thin leaves. The leaves tend to grow in whorls of three up the stem. The deep rich colours of bell-heather are often responsible for the glowing autumnal purple hues that are so typical of the Scottish Highlands.

Bell-heather is attractive to honey bees, which make deep port-coloured honey from the nectar. Bumble bees sometimes make holes at the base of the petals in order to get at the nectar, and honey bees exploit this short cut.

Cross-leaved heath looks rather like bell-heather but it tends to grow in wetter areas. It gets its name from the whorls of four leaves along the stem. You can also distinguish it from bell-heather by its drooping flowers, which are arranged in clusters at the tip of the stem. Each bloom is pendulous and moves in the wind, but after pollination, usually by small insects, the fruits become upright. Cross-leaved heath is also self-pollinated.

Heather and heaths have been extensively hybridised by horticulturalists, and many different varieties exist. There are a number of gardens open to the public where visitors can see different heaths in flower during each month of the year. Two of the best places to see a really choice variety of species are the Botanic Gardens in Edinburgh, and the Ness Botanic Gardens on the Wirral in Cheshire. Here you can find a marvellous array of richly coloured species.

Left: Heather, or ling as it is often known, is our only native species of true heather. It flowers from August to September on moors, bogs and in woodland on acid soils throughout the British Isles. Ht 100cm (40in).

Left: Heather has long been used for numerous purposes: you can tie several branches together to make a good broom; a patch of heather, so long as it is nowhere near gorse, makes a comfortable outdoor bed on a long moorland walk, and in the past it was often used to stuff mattresses. The stems were woven for thatching, and it also made good fuel.

ANIMAL LIFE IN LAKELAND

It can take a lifetime to appreciate the wildlife of the Lakes: rare fish and protected bird and animal species are found in the district's many and varied wildlife habitats.

Any journey in the Lake District will take you through frequent changes of scene from rock, marsh, grass and woodland to water – a profusion of contrasting animal habitats next door to each other.

The district has its characteristic range of insect life and, not surprisingly with its many different kinds of waters, the speciality is in aquatic and semi-aquatic insects. Living by the lakes and running water there are 25 species of mayfly and 20 species of dragonfly. At the same time 25 species of stonefly, grey-black insects with flat-folded wings, can be found by the waterside, and a baffling 106 species of caddis flies flit about, some drab and grey, some with beautifully delicate

Below: One of the most famous and endearing views in the Lakes is Tarn Hows. It is in fact a man-made landscape – the stream was dammed to make the lake, and trees were planted that are alien to the Lake District.

colours.

In the rippling waters The brown trout is the Lake District's most common fish and, in a large lake such as Windermere, can grow to a length of 60cm (24in), but in streams trout do not reach more than a third of that size. The sea trout is a migratory form of the brown trout, and swims up from the estuaries to spawn in the upper reaches of streams. (The trout article on page 33 describes the remarkable life cycle of these fish.)

Nowadays fewer salmon come up the Lakeland rivers to spawn, but the occasional one still appears. The salmon's relative, the charr, is found in eight lakes: Windermere, Coniston, Ennerdale, Wastwater, Buttermere, Crummock Water, Thirlmere and Haweswater.

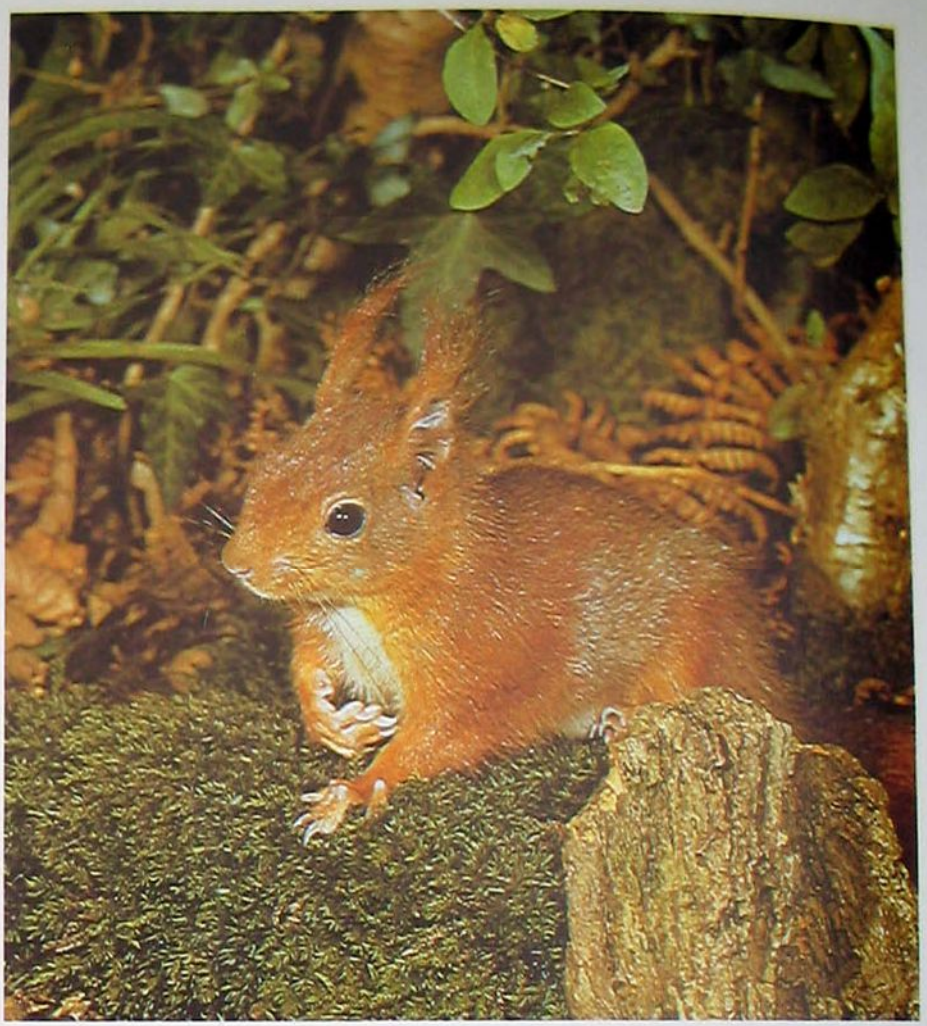
Two whitefish of the Coregonidae family are special rarities of the Lake District: the schelly (skelly) which smells like cucumber when fresh, and the vendace. The schelly is a plankton feeder, growing to a length of 40cm (16in) and inhabiting Ullswater, Haweswater and the Red Tarn on Helvellyn. The vendace is about half the size of the schelly and its only Lakeland habitats are Derwent Water and Bassenthwaite Water, two lakes that were formerly joined.

In the more productive lakes the characteristic fish are perch and pike, although trout may also occur. Unfortunately in 1976 an unidentified disease wiped out over 98% of adult perch in Windermere, and the species will take years to regain its former numbers. Eels are trapped commercially in various parts of the Lake District and transported live to London. During the 1980 season two tonnes of eels were trapped in Windermere, to become ingredients for eel pie, stewed eel and other traditional East End delicacies.

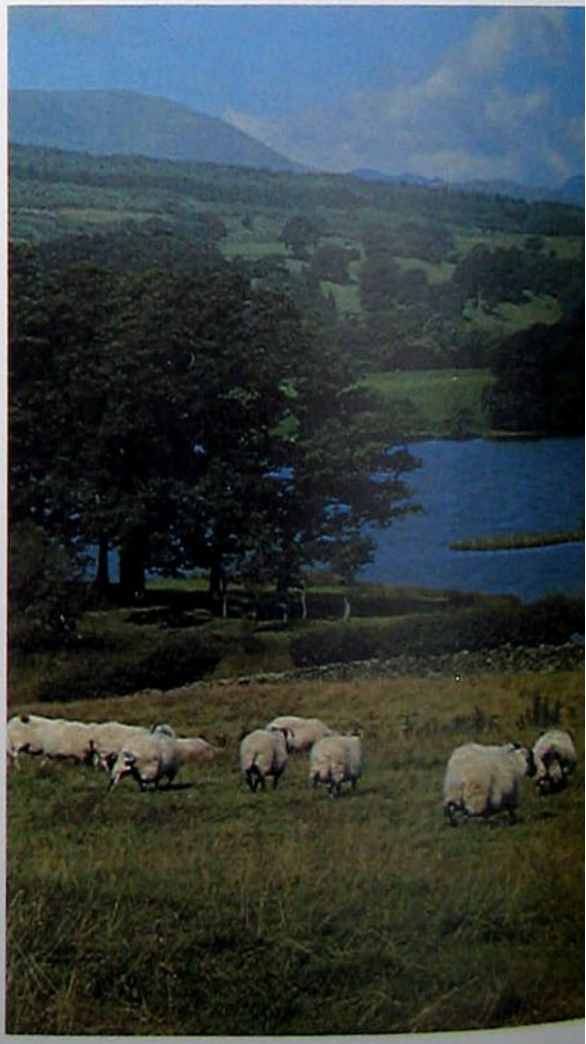
Of the smaller fish, bullheads are found under stones both in becks and at lake edges; they are small fish that rush away with a flapping of their tails when discovered. Another small fish of the becks is the stone loach. Minnows swim in shoals in gravelly areas at lake edges, and three-spined sticklebacks frequent the weedy areas of lakes.

Snake spotting When out walking or picnicking in the Lake District, always bear in mind the possibility of coming across an adder (viper). These snakes bask on sunny banks or fellsides, so take care not to tread on them or sit on them. It is not that they are a great menace, for they hurry away whenever they have a chance; but naturally they react quickly if surprised.

On the danger list Buzzards, ravens and the magnificent golden eagle have been persecuted almost to extinction in the Lake District in the past, but have now started to stage a comeback. The buzzard is doing fairly well nesting in the woodlands, and the harsh croak of the raven can be heard on the fells once again. Its larger size and wedge-shaped tail distinguish it from the carrion crow.



Above: Perhaps the Lake District's most attractive mammal is the red squirrel, which at the moment is abundant. The grey squirrel is a rather scarce intruder.



Right: Typical of today's Lakeland herds, these sheep at Esthwaite are of mixed breed. The famous old breed of the district is the Herdwick; today Swaledales are gradually replacing them. You can also see Scottish Blackface, Rough Fell and Dalesbred sheep in the Lake District.

There are still very few golden eagles about, and they are protected with great care. The peregrine falcon is another bird that has suffered badly.

The commonest bird on the fells is the meadow pipit, which arrives in March or early April and leaves the district by the end of September. Wheatears are common breeding birds of the fells, and ring ouzels are frequently seen.

Woodland, stream and lake birds The oakwoods do not have a rich variety of bird life, but one species that is rather special to Lakeland is the pied flycatcher, an attractive bird which takes advantage of the nesting boxes provided for it to increase its range. Other woodland dwellers are sparrowhawks, the green and the great spotted woodpeckers, and woodcocks. Nightjars, which were fairly common at one time, have now become extremely scarce.

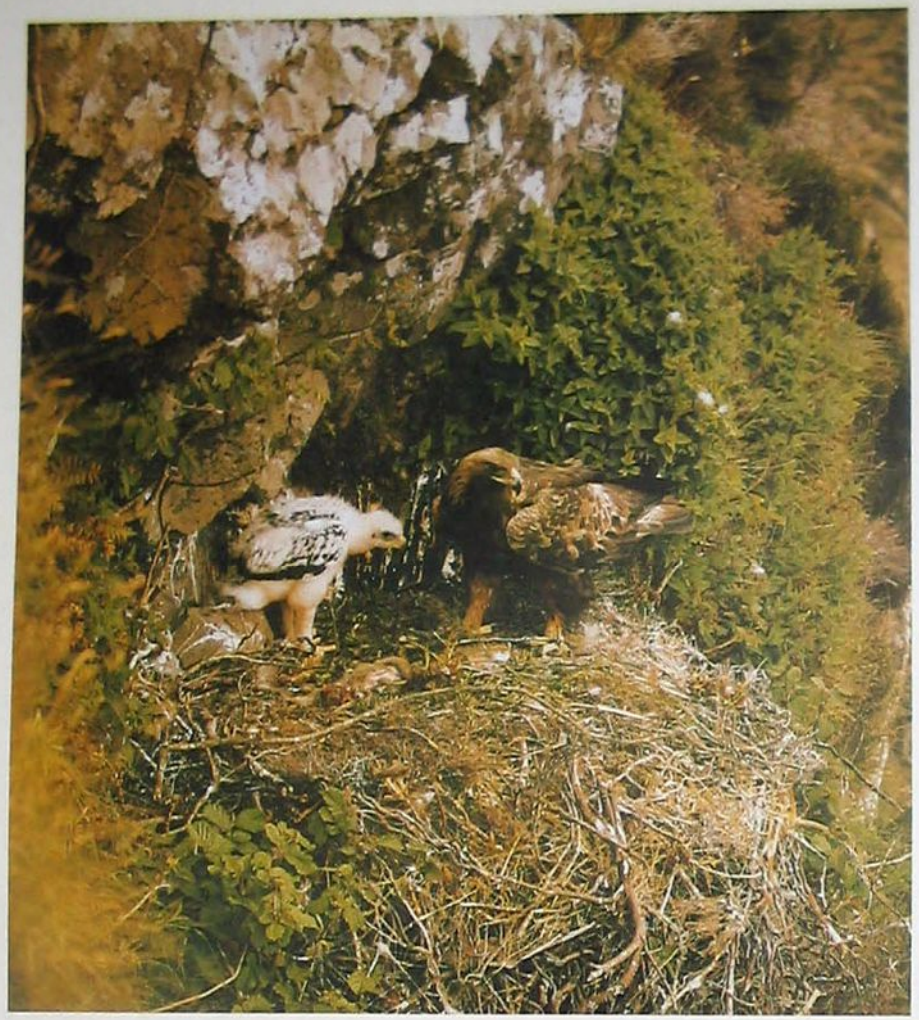
Dippers seem to prefer wide, shallow rivers in the valleys rather than upland streams. Grey wagtails show the same preference. The yellow wagtail is becoming a familiar sight in summer, in meadows beside lakes and rivers. The kingfisher, however, has declined in recent years.

Nor do the lakes have a great variety of bird life; perhaps this is because the deep water and the frequently bare shores, stony and lacking in plant cover, are not favourable to a wide range of species. The common sandpiper nests on lake shores that are less open to human disturbance. Great-crested grebes nest on smaller lakes such as Esthwaite and, in recent years, red-breasted mergansers have nested in some numbers on Windermere. The broods of young swimming after their parents are a charming sight for visitors.

Above: The north-west coast of Cumbria is one of the strongholds of the natterjack toad. This rare and protected animal survives in the sand dunes, where large areas are unfrequented because of military use.

In winter the bird population of the lakes and larger tarns increases with the arrival of large flocks of mallard, and the diving ducks: tufted duck and goldeneye come first, and the pochard later. The most spectacular arrivals are the whooper swans from the north, which start arriving in small parties from the middle of October.

Coot occur in large numbers in winter and



Above: One or more pairs of golden eagles have returned to nest in the Lake District with varying success; a major hazard for them is disturbance by people.

on Windermere parties of over a thousand strong have been observed. Cormorants, too, visit several lakes, looking somewhat incongruous in these surroundings. They feed mainly on perch.

The mammals The most common mammal in the Lake District, as almost everywhere else in the country, is the short-tailed vole, whose grassy runs can be seen even on the tops of the highest fells; it is the main prey of all the predatory birds and animals. The Forestry Commission plantations, which exclude sheep, thereby increasing the long grass, have enabled the voles to grow in numbers.

Surprisingly, the blue (or mountain) hare, in spite of its deliberate introduction to the Coniston area before World War I, is today not found in the Lake District; and the commoner brown hare is not found on the fells as often as in the woodland, for the grasslands are inadequate to provide it with enough food.

As elsewhere, badgers have been reduced in recent years by gassing and digging-out. Otters too have declined, as a recent otter survey has shown. The principal cause of their decline is the presence of man: not hunting, which is now illegal, but disturbance, and possibly the use of chemicals in farming which have a toxic effect on the otters.

One mammal which continues to exist in competition with man is the fox. All farmers unite in supporting the fox hunt; they are anxious to prevent depredation of their lambs and poultry, but the hunt is not an effective means of keeping down the numbers of foxes, for in a hill country with many natural rocky retreats it is almost impossible to eradicate such a cunning animal.

The Lake District has the only deer forest in England. The wild red deer of Martindale run freely on the fells, without any form of enclosure. Except during the rut in autumn the stags roam on their own, away from the females (hinds) and calves in the main home range. Picnickers are sometimes alarmed by the sudden appearance of a stag, wandering in search of a resting place.

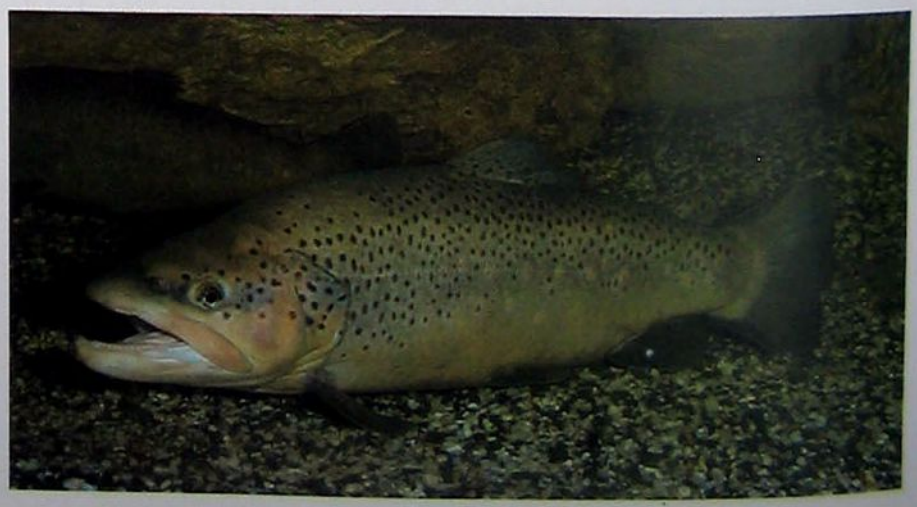
Smaller groups of red deer are found in other parts of the district, such as Thirlmere and at the southern edge of the National Park in Furness. In the forestry plantations at Grizedale, near Hawkshead, high seats have been provided to enable visitors to watch deer.

Roe deer, as in many other parts of Britain, have increased their populations in recent years, and live in small groups in many woodlands throughout Lakeland. During the day they remain sheltered and out of sight, but come out at dusk to browse, and at this time of day they are liable to rush across a road, and can cause accidents. Road signs warn of this danger on roads that pass through the areas where the deer are numerous.

Destruction or conservation? The Lake District is an incomparably beautiful landscape. It is also a rich legacy of wildlife. Great pressures are now imposed on this fragile environment, on the one hand by the demand for more intensive farming and forestry, and on the other by the vast increase of mainly car-borne visitors who infiltrate even the remote areas and leave no place untouched.

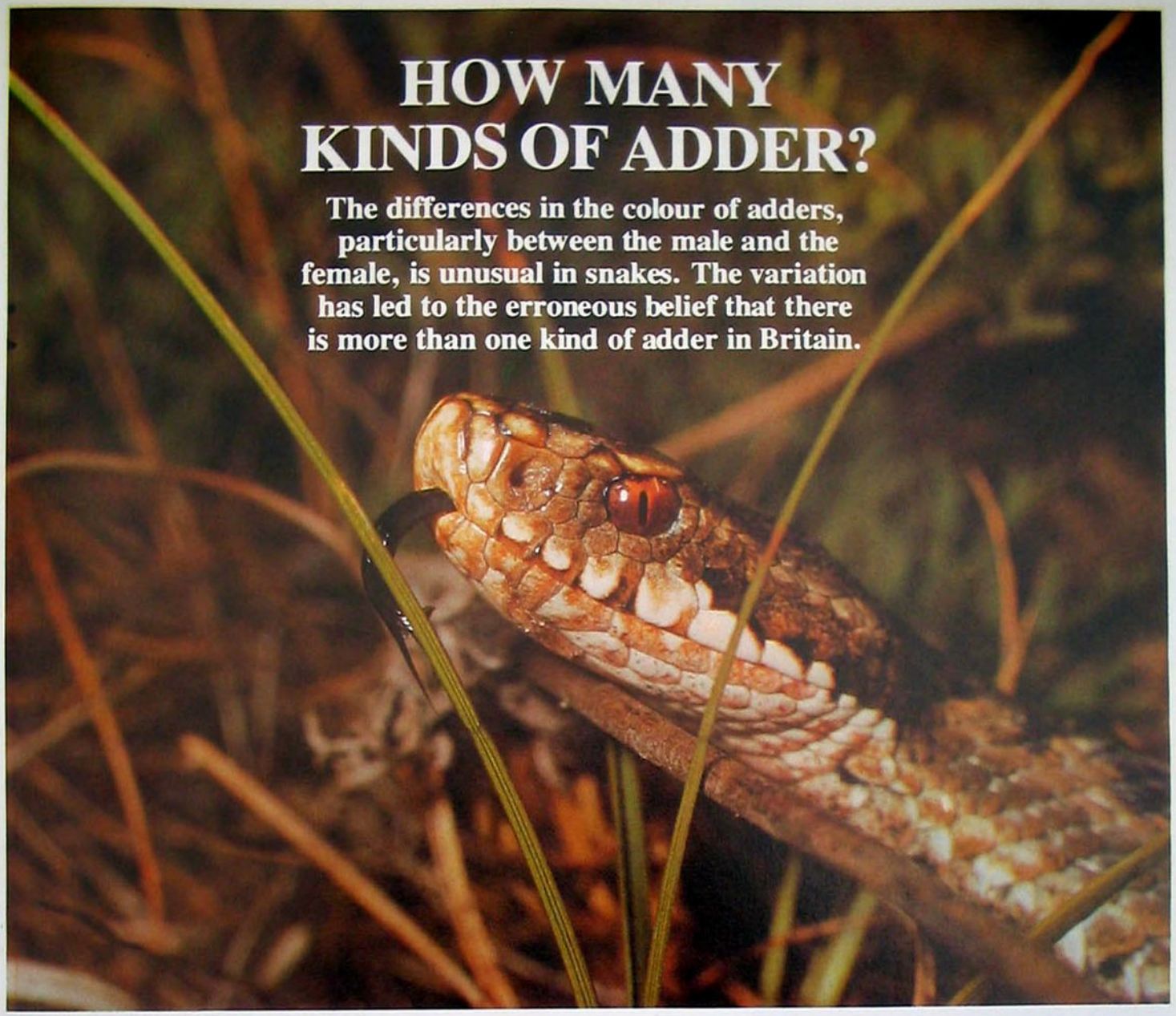
The recent histories of the golden eagle, the peregrine, the pine marten, the now absent polecat and the endangered natterjack serve to warn us that the future for wildlife is bleak. Yet we seem unable to resolve the problems of preserving even areas which have been chosen as national parks. Is it too much to hope that the younger generation, many of whom will be readers of this magazine, will bring new hope to the countryside?

Below: The brown trout of the lakes move up into the streams to spawn. The eggs are laid in mid November, and the young fish (alevins) hatch in early March. These remain in the river until they are about two years old, then return to the lakes.



HOW MANY KINDS OF ADDER?

The differences in the colour of adders, particularly between the male and the female, is unusual in snakes. The variation has led to the erroneous belief that there is more than one kind of adder in Britain.



The adder, or common viper, is the most widely distributed of our three native snakes, and the only poisonous one. Within mainland Britain the adder is found particularly in heathlands and open woodland. However, it does not occur in Ireland.

The common name adder derives from the creeping behaviour of this snake and was once written nedre (or eddre), which is the Anglo-Saxon for nether or lower.

Zig-zagging Compared to the grass snake (see page 308) or the smooth snake, the adder is a stocky reptile. Its best distinguishing feature is the zig-zag pattern which extends from the back of the snake's head to its tail. This striking marking may be a broken stripe or continuous. Naturalists are still speculating on what purpose it serves: the zig-zag could be a warning to potential enemies but it can also assist in camouflaging the adder because the markings resemble dead and broken bracken fronds and other plant debris.

Colour confusion The colour of the adder is particularly interesting because differences between males and females (sexual dimorphism) are rare in snakes. Adult female adders are usually brownish or reddish-brown with dark brown markings, whereas males are normally a contrasting black and pale grey, with a rather obvious black zig-zag pattern. On the underside, both sexes are usually grey or greyish brown with small white spots. Some adders are darker in colour or totally black (melanic) with no visible pattern or marking.

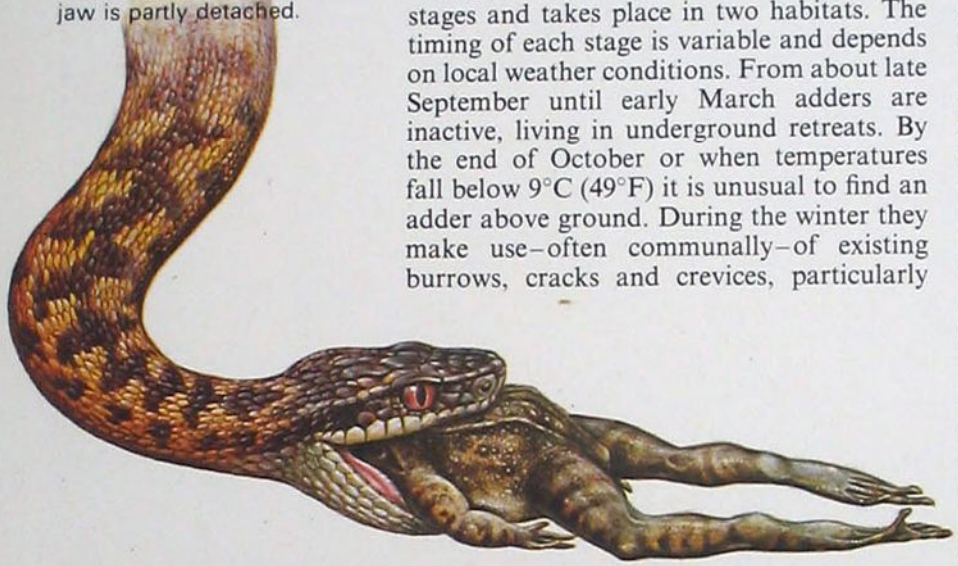
The colour of young adders is also variable. Young males tend to be similar to adult males but young females are usually a brick-red colour with a dark red or brown zig-zag pattern. The differences in colour have led some people to think that there were three different species of adder in Britain, when there is, in fact, only one.

Carnivorous diet The diet of the adder consists chiefly of small mammals (particularly mice and voles) but it also includes other reptiles and amphibians. The adder can climb trees to a height of about 2m (6½ft) and take nestling birds from nests. The young adder also feeds on insects, newts and small

Adder *(Vipera berus)*, 55-60cm (21-23in) long, female larger than male, but has shorter, thicker tail. The generic name *Vipera* was given because adders do not lay eggs but give birth to live young (they are viviparous). The origin of the specific name *berus* possibly originates from the 13th century, when it was used to refer to a mythical water serpent with terrible venom.
The adder favours warm sites with south facing banks in open woodland, among bracken, on heathland or in other undisturbed places. The red, sometimes orange, eye of the adder (above) has a slit-like pupil which helps to distinguish it from our other native snakes.

Poisonous predator

The adder strikes suddenly (below) by lunging forward and piercing its prey (in this case a frog) with its venomous fangs. Once the poison reaches the victim's blood stream, it dies within a minute or so, because the poison destroys the blood cells. The adder then swallows its food by 'walking' its jaws over the prey. The snake's fangs are folded back, and the lower jaw is partly detached.



mammals (it can overpower and eat a mouse which is more than half its own weight), but it seems to favour small lizards.

Like many other snakes, the adder can detect prey not only by sight and sound, but by picking up vibrations made by movement. In addition, the in-and-out flicking of the adder's tongue is used to detect chemical signals and can be important for locating prey. Less is known about how predators kill adders, but there is no doubt that foxes, hedgehogs, badgers and birds of prey attack and eat them.

Winter retreat The adder's year has two stages and takes place in two habitats. The timing of each stage is variable and depends on local weather conditions. From about late September until early March adders are inactive, living in underground retreats. By the end of October or when temperatures fall below 9°C (49°F) it is unusual to find an adder above ground. During the winter they make use–often communally–of existing burrows, cracks and crevices, particularly under or among tree roots.

Why do adders share a winter den? There are two answers: first, there is a scarcity of secure, safe sites which give protection from frost, but do not become too dry; secondly, many snakes coiled together help to keep each other warm.

Emergence into spring Adders become active again from April to September, and spend this period at a summer habitat which can be as far away as about 2km (just over a mile) from the winter habitat. On rare occasions you may find an adder above ground in January, but this is only likely during fine warm weather in the southern counties.

Towards the end of February, or in early March when air temperatures rise above 8°C (46°F), the male adders emerge to bask in the spring mid-day sunshine. Many adders use the same wintering site, so it is not unusual to find several male adders basking together. At this time the males are preparing themselves for mating by making sure that they keep their body temperature relatively high–at about 30°C (86°F).

The females emerge after the males. While the males tend to bask near the winter den, the females move further afield where they remain for a week or so before moving to their summer habitat. During April or May the males also move toward the summer habitat and in doing so they find the females and mate with them. Mating therefore usually occurs before the adders settle in the summer habitat–from late April to May. The males locate the females by chemical signals, using their flicking tongues to pick up chemical odours; in this way they detect and follow the trails left by the females.

Rivalry for mates The best chance you have of catching sight of one of the most fascinating aspects of wildlife behaviour occurs just before or during the adder mating season. In the 'dance of the adders' two male snakes raise themselves above the ground, then coil themselves around each other, while endeavouring to push each other to the ground. This rivalry between males occurs frequently when there are many snakes in one area. The swaying bodies of the rival snakes is a sight never to be forgotten, yet this behaviour has rarely been captured on film.

Delayed birth After mating, the time taken for the young to develop within the mother (gestation period) normally lasts several weeks until she gives birth during late August or in early September. Unlike a mammal, the female adder does not form a placenta to nourish her developing young but retains membrane-covered eggs (without a hard shell) in her body.

Whereas mammals have a regulated period of pregnancy the speed of the baby adders' growth depends upon weather conditions. As the male needs the sun's radiation to speed up the process of sexual maturing, so the

The colour of the adder is fascinating because of its variability, especially between the sexes. This is rare in other snakes. This female (left) is browny beige with darker brown markings, while this male (below) is a dark olive-brown with black markings. Whether it is male or female, you can tell it is an adder by the characteristic zig-zag pattern that runs along the length of its body (except in melanic individuals which are a uniform black in colour).

female needs to have quite a high body temperature for successful development of the young.

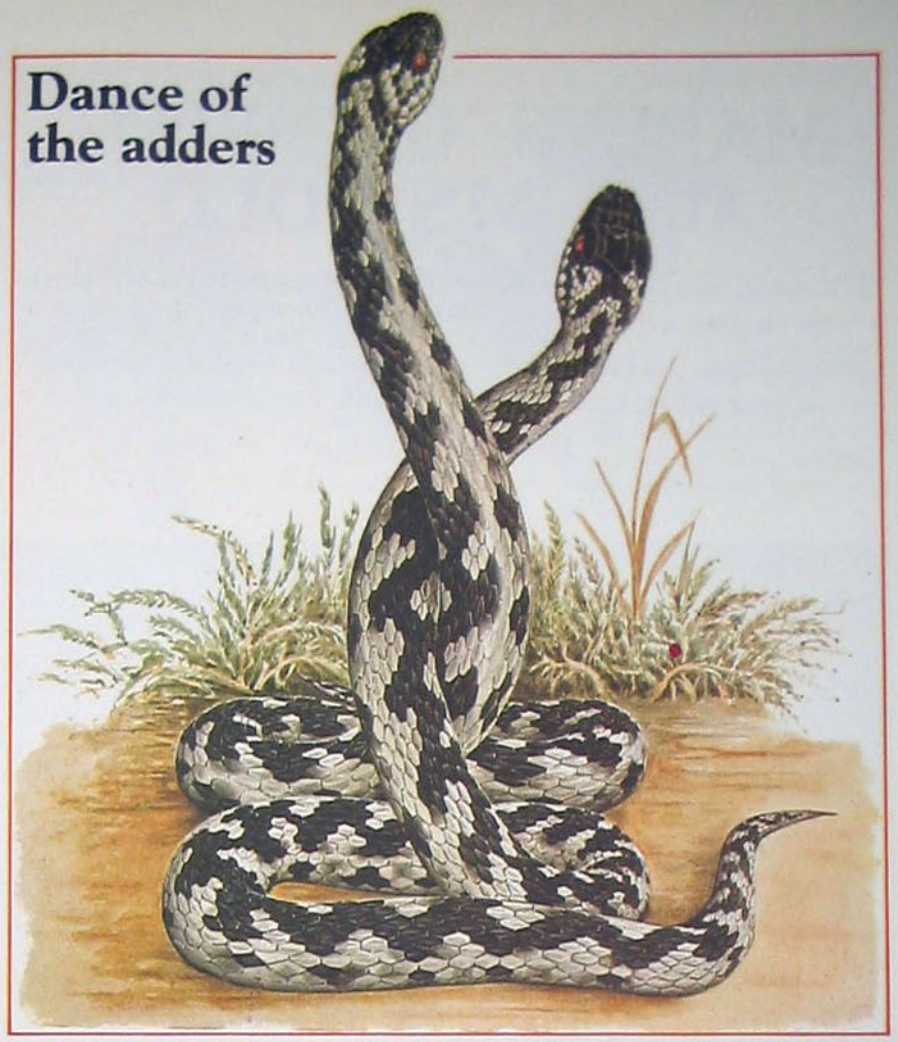
Since the British summer is often cold, it is not unusual for the birth to be delayed. If it is a particularly cool summer then birth can be delayed until the spring of the following year. It takes a lot of food and energy for the adder to nourish and give birth to young, so much so that in cooler regions (including the British Isles and as far north as the Arctic circle) where the weather makes it difficult for the adder to find food, females give birth only every second or third year. In warmer countries–adders occur as far south as northern Italy–they give birth every year. So adders adapt their reproductive behaviour to suit their native climate. This unusual reproductive biology accounts for the adder's widespread distribution–rivalled among reptiles in this country only by the common lizard (see page 361), another species that has evolved the ability to retain the young inside the mother, instead of laying eggs.

Baby snakes Adders give live birth to about 12 young at a time (though 20 has been recorded). At birth each baby snake is coiled within a thin membrane, which it quickly ruptures by vigorous jerking movements. Perhaps this accounts for the 12th century legend that baby adders bit through their mother's body to escape, killing her in the process.

Newly born adders reach about 16cm (6½in) long, before they retreat with the adults for their first overwintering. Thereafter they grow rapidly at about 10cm (4in) a year. They eat small insects, later graduating to vertebrate prey such as newts, then on to the adult diet of lizards and small mammals. On these successive diets it takes about three or four years for adders to reach adult size; they then live for a further five or six years.

A good sign that adders are present is the cast skin (slough) which they leave behind after they have moulted. As the young adders grow, they shed their delicate outer skin, usually twice a year; and this tell-tale sign remains on the ground for quite a long time.

Dance of the adders



Above: Once thought to be part of the courtship display between male and female, the 'dance of the adders' is now known to be a form of aggressive behaviour between rival male adders that occurs prior to, and during, the breeding season.

Left: Some adders are extremely dark in colour, or are totally black (melanic) with no visible pattern or markings. The young melanic individual, tucked under this adult is newly born and about 16cm (6in) long.
If alarmed, baby snakes may disappear quickly under their mother–giving rise to an ancient, fiercely disputed legend that female adders will swallow their young to protect them. People apparently believed this when they found live babies inside adders they had just killed.
Although young snakes may remain near their mother for a few days after birth, the adults do not seem to look after them.

MAPLES: GLOWING AUTUMN GOLD

The field maple is our only native maple species and it is rather a small tree; but what it lacks in size it more than makes up for by the brilliance of its fine autumn foliage which turns to vivid shades of golden yellow.

The field maple usually grows in hedgerows, either as a small tree with a neat rounded crown, or chopped right back to a bush forming part of the hedge itself. It is also found among hillside scrub, at the edges of woods, and in the shrub layer of oakwoods where in the past it was usually coppiced. It grows best on chalk and limestone soils and is thus widespread in southern and eastern England, but less common in western and northern districts. In Scotland and Ireland it has been introduced and has a rather scanty distribution.

Britain's native maple The trunk is covered with pale greyish-brown bark which, in older trees, is cracked by a network of

fissures. The winter twigs are light brown and scored along their length by shallow furrows. Older twigs tend to develop prominent longitudinal ridges of corky bark. The small brown buds are carried in opposite pairs along the length of the twig, and they break open in early May to release the young leaves.

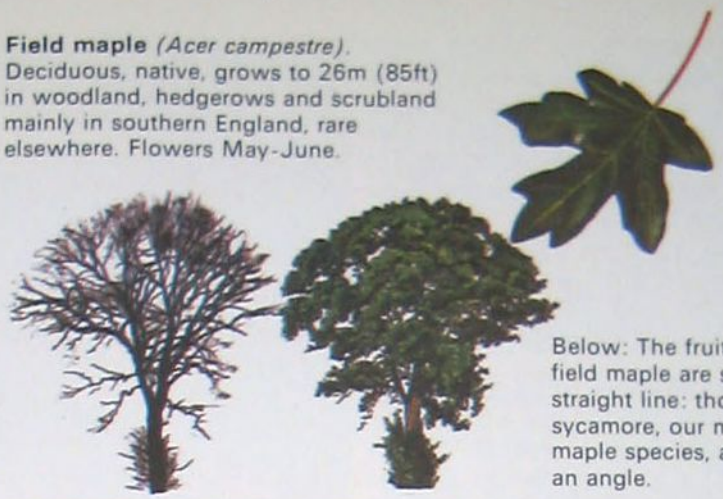
The fresh young leaves hang limp and are pale yellow-green with a coating of fine hairs. Their upper surface has a noticeably glossy sheen. Later, as the leaves expand, they stiffen and turn a darker shade of green. The leaf-blade is divided into three or five distinct lobes which are separated by deep indentations. Each lobe has bluntly toothed edges and a rounded tip.

Leaf size can vary enormously: the leaves on a regularly trimmed hedge are generally about half the size of those on free-growing trees. The leaves are borne on leaf-stalks 4-8cm (1½-3in) long which are light green or streaked with red. If you cut the leaf stalk it bleeds a white milky sap.

The field maple flowers shortly after the foliage has unfurled. A loose cluster of 10-20 greenish-yellow flowers is supported on a stalk that grows upwards between the terminal pair of leaves on each twig. Each flower has five green petals surrounding eight stamens, which are tipped with yellow pollen-bearing anthers.

Insects, and particularly bees, feed on the pollen and nectar and as they do so they transfer pollen from the male anthers to the central female style. The style is situated at the top of the ovary which is made up of two green flattened lobes. After fertilisation the ovary develops rapidly into a pair of broad-winged keys (samaras). They hang in bunches throughout summer, slowly changing colour from a crimson-tinged green to brown by autumn. When the seeds fall from the tree the wing gives them a spinning motion.

Field maple *(Acer campestre)*. Deciduous, native, grows to 26m (85ft) in woodland, hedgerows and scrubland mainly in southern England, rare elsewhere. Flowers May-June.



Below: The fruits of the field maple are set in a straight line: those of the sycamore, our most common maple species, are set at an angle.

Far left: A hedgerow of brilliant field maples on a sunny autumn day.

Below: The leaves of the field maple turn red and gold in autumn.

Timber Field maple wood burns well but because of the meagre size of the tree it has never been widely used. The pale brown timber has a well marked grain which is still valued by craftsmen. The wood from the roots, with its beautiful swirling pattern of veins, shows up well when polished.

Sycamore look-alike Field maple can be confused with the sycamore (page 461), but there are several differences: the sycamore's winter twigs are smooth, with yellow-green buds; sycamore leaves, although similar in shape, are larger than those of the field maple, and the lobes more pointed and not so widely separated; also the samaras of the field maple have broader wings set in a straight line, whereas sycamore samaras are joined at an angle of about 55 degrees.

Sugary sap The sap of all maple species is especially rich in sugars. When growth surges ahead in spring there is a great flow of sugars from the winter storage organs to fuel the development of shoots and leaves. In northern Europe the sap was collected in cups set under hollow tubes driven into the trunk. The liquid was boiled over a fire to concentrate it into a thick sweet syrup. Nowadays the main source of maple syrup comes from the sugar maple (*A. saccharum*) which is widespread in much of the deciduous woodland of north America.

Spectacular introductions Norway maple is our most widespread introduced maple and it is widely grown for ornament in parks and gardens. In a few places it has escaped and become naturalised in the wild, although not nearly so vigorously as the sycamore. Its decorative value is largely due to the beauty of its foliage: when its leaves unfurl in spring their delicate green is shot with shades of pink, crimson and russet, changing in autumn to tones of bright yellow and shining gold.

There are many species of maple in North America – indeed, Canada has adopted the maple leaf for its national emblem. Maples are renowned for their spectacular displays of autumn colours. The 'fall' in New England is justly famous for the blaze of colour – reds, oranges and yellows – in great expanses of maple woodland.

Two North American species are frequently planted in the British Isles. They are the red maple (*Acer rubrum*) which has striking autumn foliage, and the silver maple (*A. saccharinum*) which has sharply toothed leaves that flash a silvery sheen from their undersides as they are rustled by the wind. From further afield the Japanese maple (*A. palmatum*) is planted for its graceful form and deeply lobed leaves, each shaped like an outstretched hand. It thrives in the warmer areas of the British Isles.

Norway maple *(Acer platanoides)*. Deciduous, introduced but often naturalised in woodland, hedges on most soils. Often found with sycamore. Flowers May-June.

Autumn leaves

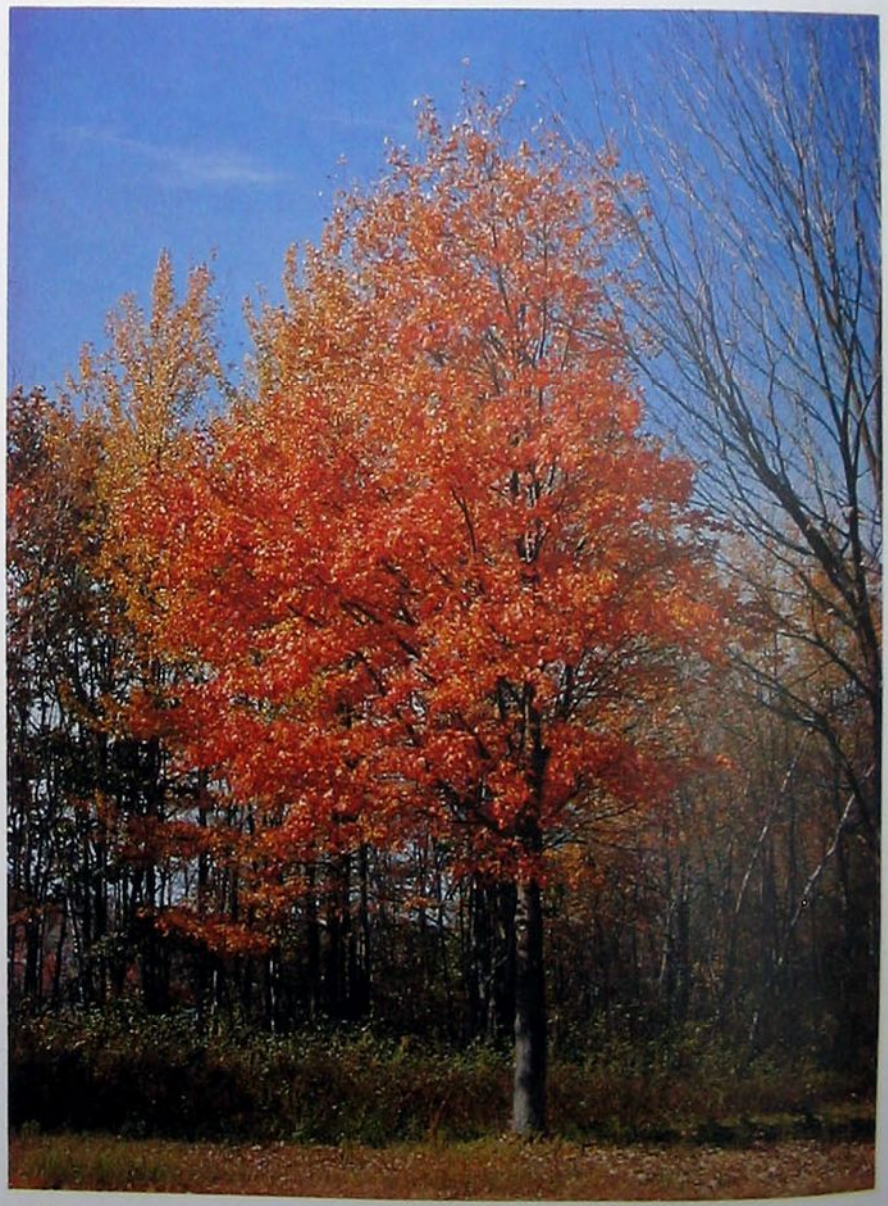
The colourful autumn finery of maples reflects a period of intense activity by the trees. Most of our broad-leaved trees are deciduous, shedding their leaves as the days get shorter and the weather colder. Leaves continually lose water by evaporation; in summer it is replaced by water pumped up from the roots, but in winter roots cannot absorb enough water to supply the needs of the foliage. This may be surprising, considering our high rainfall, but as the soil temperature drops, so the roots work less efficiently, and ice cannot be absorbed at all. To avoid water loss, many trees shed their leaves.

Evergreens can retain their foliage because the leaves are coated with a waxy surface layer that reduces water loss.

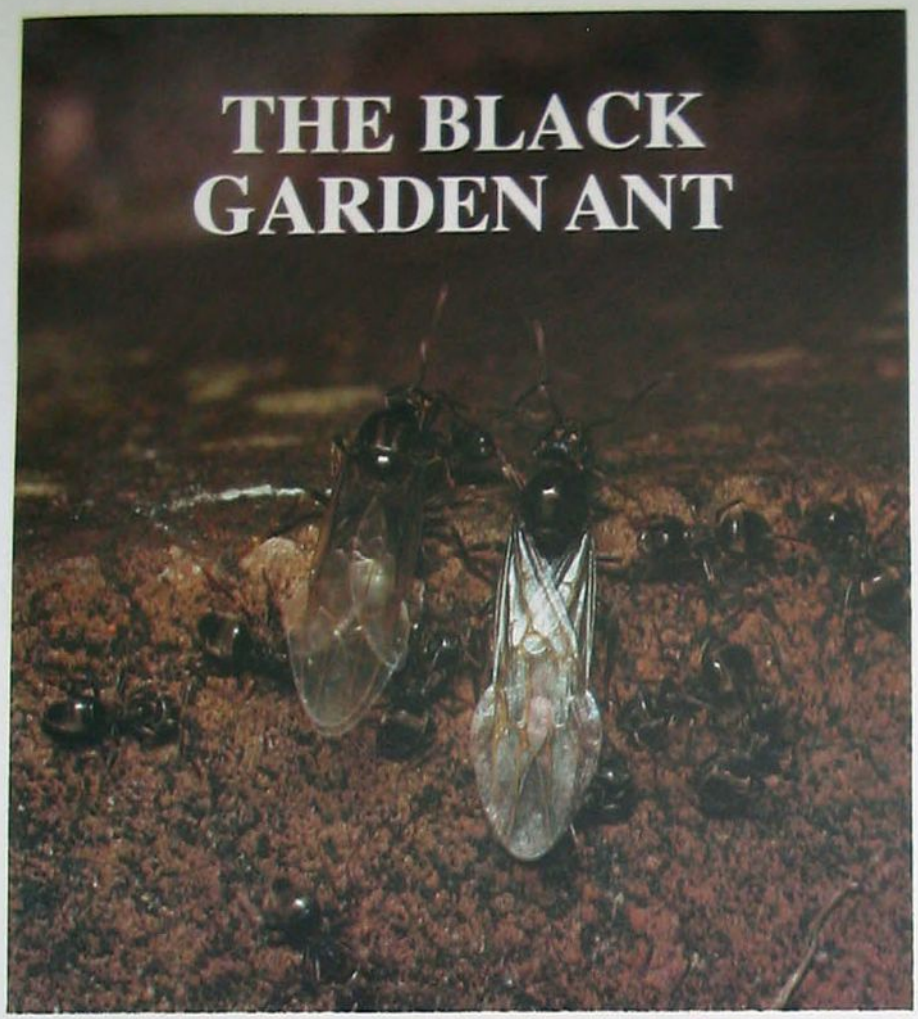
Before leaves are shed, their colour changes and the resulting tones are due to a change of pigment concentration, and the accumulation of waste products from the rest of the tree.

As the foliage assumes its autumnal tints the tree drains most of the nutrients from the leaves to store in the roots and trunk to tide it over winter. In spring they rise in the sap to fuel the intensive growth activity before the new leaves produce enough new food by the process of photosynthesis.

Once the foliage is redundant a waterproof cork layer forms at the base of each leaf stalk, cutting the leaf off from the tree. The joint is weak, and the leaves are either blown off or fall after a frost which ruptures the join. The cork seals the wound left by the fallen leaf, and so protects the leaf scar and other parts of the tree from invasion by harmful fungi and various different kinds of bacteria.



THE BLACK GARDEN ANT



Lift a paving slab or turn over a large stone in the garden, and the chances are that you'll find a colony of black garden ants. This species takes to the air in swarms to mate on warm, humid summer days.

Above: Black garden ants (*Lasius niger*) swarming. The two winged individuals are queens or males (in this picture they are too small to distinguish) which will take to the air to mate. The wingless forms are sexually underdeveloped females (workers).

The black garden ant is widely distributed in the British Isles, but is most common in the southern third of England. It is a dull black, rather hairy ant and occurs in fields as well as gardens.

If you look into the black garden ants' nest at any time from late July to the end of September, you'll find three different types of ant. The largest individuals are queens; they have four thin, transparent wings. The smallest ones–also winged–are males, while the slightly larger wingless individuals are workers. For most of the rest of the year the workers are the only easily seen ants in the nest.

Mating swarms The black ants' mating flight takes place in summer in warm, humid weather. Males and queens emerge from the nests in swarms–those from nests in the same neighbourhood all appearing at much the same time (usually about mid-day). They take to the air in vast numbers, then disperse. Many fall victim to predators such as swallows. Mating takes place in flight; afterwards, the queens settle on the ground tear off their wings and either return to their original nest or find a suitable place under a log or stone to overwinter. The males die soon after mating.

Colony life In spring the mated queen starts laying eggs. These develop into workers which build up the nest. Later in the summer new winged queens and males are produced, the males from unfertilised eggs.

Life in the ant colony centres on the queen. She is carefully tended by the workers who feed her a regurgitated sugar-rich fluid which was gathered as honeydew from aphids, or from the nectaries of flowers. The queen's eggs are taken to special brood chambers and guarded and the larvae, when they hatch, are fed and cleaned.

Foraging Apart from the honeydew and nectar, black garden ants eat flies and other small insects and mites, as well as crumbs dropped by people. They also gather the seeds of plants such as violets for the fat-rich body (elaiosome) they contain.

Black garden ants are themselves eaten by a variety of predators. The green woodpecker, for instance, scratches into the ants' nest and extracts ants with its long tongue. Some ground and rove beetles, spiders and centipedes also prey on ants, and even members of the same species attack their own kind if they come from a different nest.

Right: Black garden ant worker with larvae (the small white grubs) and pupae (the cocoons).

Milking aphids

Ants are attracted by the sugar-rich fluid–honeydew–that is secreted by aphids. The ant 'milks' an aphid by stroking its rear end with its antennae; this appears to stimulate the aphid to secrete a drop of honeydew which the ant eats and regurgitates later in the nest to feed queen or larval ants. Sometimes ants appear to protect aphids from predators by squirting formic acid.

HARDY SHEEP OF THE HILLS

Almost no climate is too harsh for the sheep that graze on the inhospitable slopes of our hills and mountains. These tough native breeds can withstand driving rain and icy winds, and may even survive in deep snow drifts for several days.

Below: Hill sheep are often crossed with lowland breeds to produce fat lambs which will fetch good meat prices. The blackfaced lambs shown here are the result of a cross between the Cheviot ewe (also shown in the picture) and a Suffolk Down ram.

The hill sheep's year begins in autumn, when the ewes and rams are prepared for mating. Only sheep which are fit and healthy are used for breeding. They are dipped and drenched (given medicine) to remove external and internal parasites, and their hooves are trimmed. Each ram runs with between 60 and 100 ewes.

Mating is arranged to fit in with the best time for lambing, which coincides with the growth of grass in the spring. In most areas, mating starts in mid-November so that the lambs are born in April and the beginning of May. The gestation period in sheep is almost five months. During the winter the pregnant ewes need careful attention. For most of the time, they forage for themselves, even digging through a light snow cover to graze the coarse grass and tips of heather below. In heavier snowfalls, the shepherd provides hay, and he gives sheep in late pregnancy a higher-energy feed to ensure that they have adequate nutrition.

Lambing Before the lambs are due to be born, the ewes are brought into smaller pastures or fields near the homestead. Here they can be watched more closely and any ewe that has difficulty giving birth to her lamb can be given immediate assistance. Lambs are normally born with the nose and forefeet emerging first. Sometimes the lamb is in the wrong position and sometimes it is too large, but even in these cases the experienced shepherd usually succeeds in delivering a live lamb.

Hill ewes generally give birth to only one lamb each year, but in some cases twins

are born and they are at greater risk. Twins are smaller and thinner than single lambs and are less able to tolerate the cold, wet climate of April in the hills. In addition, the ewe may have insufficient milk for two lambs and her instinct may be to desert one so that the other survives. Finally, even an aggressive hill ewe has difficulty in defending two lambs against the cunning attack of predators such as the fox. For these reasons, most hill shepherds are satisfied with one healthy lamb for each ewe.

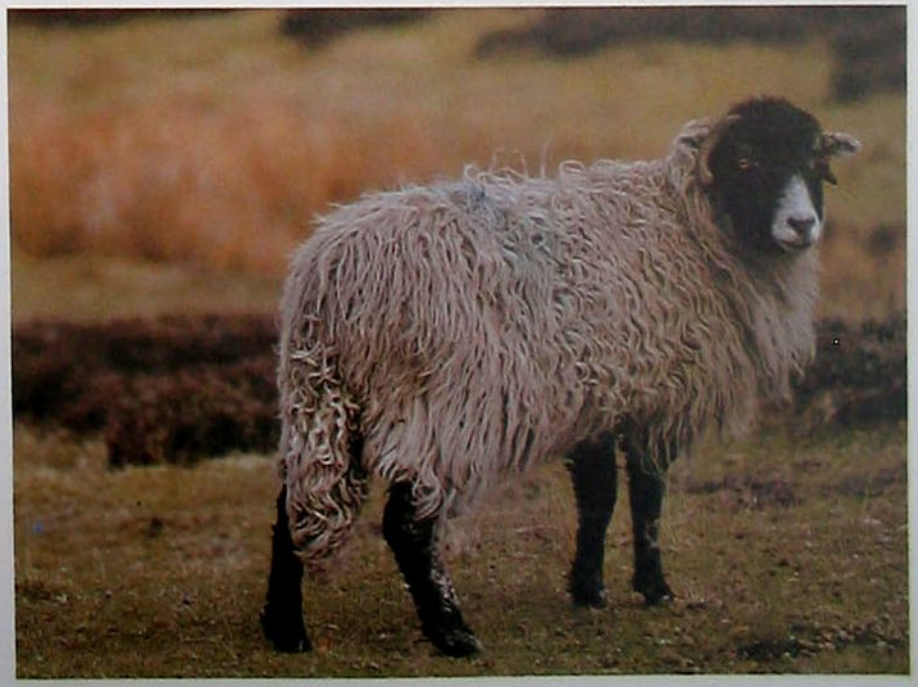
Summer is a pleasant time on the mountain grazing. With the warmth of the sun on their backs, the lambs grow quickly, and demonstrate their health and energy in endless races and games.

Shearing In June or July, the ewes no longer need the protection of their fleeces against the cold and are ready for shearing. In warm weather, the fleece rises. This means that the greasy inner layer (mat), which has been lying against the skin, lifts away from the body. The sheep can then be sheared easily by cutting through the new wool underneath the mat.

Whenever possible, sheep are shorn in the morning, partly because the shearers find it more difficult to work in the heat of the day and partly to allow the sheep more time to adjust to the loss of their protective coats before the temperature drops at night.

The shearer removes the fleece in one piece, using hand shears or electric clippers. It is opened along the chest and abdomen with the sheep in a sitting position; then the sheep is slowly turned as the wool is shorn from the sides and back. Some shepherds shear the sheep on the ground, others on

Above: Crossing of hill breeds is common, particularly in areas where breeding territories meet. This Scottish Blackface flock shows some Swaledale influence.
Right: Once the fleeces are shorn from the sheep, they are rolled ready for despatching to the Wool Marketing Board.
Below: The home of the Swaledale is the northern Pennines, but it is also becoming popular in the Lake District.



Britain's h

Scottish Blackface Horned. Long, coarse wool. Face black with variable white markings. Pronounced Roman nose. Live 59kg (130lb), fleece 2.4kg (51lb).

Rough Fell Horned. Long, coarse wool. Face black with extensive white markings. Live 56kg (123lb), fleece 2.1kg (4½lb).

Herdwick Ewes hornless, rams horned. Wool coarse, changing from black to grey or white with age. Face and legs grey. Live 46kg (101lb), fleece 1.7kg (3½lb).

Cheviot Ewes hornless, rams often horned. Wool short and soft. Face and legs white. Ears large and erect. Live 52kg (115lb), fleece 2.2kg (5lb).

special stools which give some relief from bending. Gangs of contract shearers may be employed for larger flocks.

After the fleece has been removed from the sheep, it is rolled up. First of all, it is spread out on a clean surface; the sides are turned in towards the middle; then the fleece is rolled, starting at the tail. When only the neck wool is left exposed, it is twisted into a band and wound around the rest of the fleece to hold it in a bundle.

Marking and counting After shearing, all the sheep are once again dipped and drenched against parasites. At the same time, they are counted and given the flocks's own mark of identification.

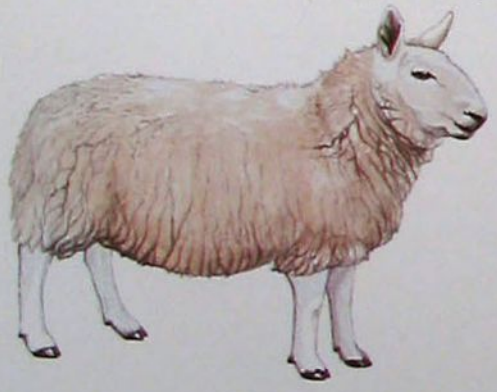
Counting is done out loud and, until recently, many shepherds used the old Norse words, 'yan, tan, tethra, methera, pip, casra, raesa, caesa, horna, dick'. Three methods of marking are used, on the horns, ears and wool. For example, in one flock in North Yorkshire, a 'T' is burned on to the left horn, the left ear is underbit (an oval shape is taken out of the lower edge), and certain marks are pressed on to the newly-shorn sheep (using a cold iron dipped in coloured fluid). These identification marks ensure that a straying sheep can be returned to its rightful owner.

A range of products Mountain lamb and mutton are famous for their sweetness, but hill sheep are probably more noted for their wool. Britain exports tweed cloth, made from local wools, all over the world.

The horns of the rams provide the raw material for another by-product, carved shepherd crooks. The spiralled horns are heated and pressed into the shape of a crook. They are then carved into the resemblance of a fish, pheasant or dog, painted and varnished, and fixed on to a staff of hazel. These crooks are carried by shepherds in the auction ring when they sell their sheep.

Regional breeds Hill sheep share a common ability to tolerate a harsh climate and exposed situations, but they vary considerably in type and appearance. Each mountain range or area has its own breeds.

The commonest group, totalling almost three million ewes, is the blackfaced, coarse-wool variety. The Swaledale originated in the northern Pennines but is becoming increasingly popular in other mountainous regions. The Dalesbred is slightly smaller and is found in the western Pennines, in the area around Bentham and Hellifield, while the Rough Fell is slightly larger



North Country Cheviot Generally hornless. Wool short and soft. Face and legs white. Live 74kg (163lb), fleece 2.2kg (5lb).

Whitefaced Woodland Horned. Wool soft and of medium length. Face and legs white. Live 59kg (130lb), fleece 2kg (4½lb).

Lonk Horned. Wool soft and of medium length. Face black with an inverted V of white over cheeks. Live 58kg (128lb), fleece 1.9kg (4lb).

hill sheep

Swaledale Horned. Coarse wool. Face black with white snout, legs mottled. Live 53kg (117lb), fleece 1.8kg (4lb).

Dalesbred Horned. Coarse wool. Face black with white snout and a white spot on each side of nose. Legs mottled. Live 51kg (112lb), fleece 1.8kg (4lb).

Whitefaced Dartmoor Generally hornless, but rams may be horned. Wool long. Face and legs white. Live 70kg (154lb), fleece 5.4kg (12lb).

and is found around Sedbergh.

The Scottish Blackface is the most numerous hill breed, with over two million ewes. Its wool is coarser than that of the Swaledale, and it has a prominent Roman nose, with more white markings. It shares the Scottish hills with the Cheviot, which contrasts sharply with the blackfaced breeds. The Cheviot also has a Roman nose, but its face and legs are white, and most of the sheep are hornless, with alert ears held erect. Their wool is softer and finer and they are less hardy than the blackfaced breeds. There are two breeds: the larger, more robust North Country Cheviot which occupies the northern parts of Caithness and Sutherland, and the more active Cheviot which is found in the hills from which it takes its name. Because the Cheviots produce high-quality mutton as well as fine wool, they have also become popular on lowland pastures.

Breeds with softer wool In the southern Pennines, three hill breeds are found in close proximity. The Whitefaced Woodland is a rare and localised breed. It is a large, horned sheep with white legs and face, and soft wool. The Lonk is midway in type between the Whitefaced Woodland and the blackfaced hill breeds: it has a dark face but soft, high-quality wool. It is found near Colne and Clitheroe in Lancashire. The Derbyshire Gritstone is large and dark-faced, with soft wool, but it is hornless. Despite its name, it is found mainly in south-eastern Lancashire.

The hill sheep of Wales are small in size compared with other hill breeds, but strong in numbers, with more than two million ewes. The Welsh Mountain has white legs and face and a fleece which varies in quality and may contain coarse red fibres (kemp). The South Wales Mountain is a little larger, with coarser wool and tan markings.

Local breeds have also been established on the hills of south-western England. The Whitefaced Dartmoor is unusual among hill breeds, for its wool is long and lustrous. The Exmoor Horn is smaller and probably the least hardy of the hill breeds.

In contrast, the Herdwick, inhabiting the highest slopes and peaks of the Lake District, is the hardiest. In severe snow-storms, sheep of this breed can survive buried in drifts for several days. Their wool is coarse and changes colour as the sheep ages. Lambs are born black but the colour gradually fades to grey or white.

Exmoor Horn Horned. Wool short and soft. Face and legs white. Live 52kg (115lb), fleece 2.4kg (5lb).

Derbyshire Gritstone Hornless. Wool soft and of medium length. Face and legs mottled. Live 74kg (163lb), fleece 2.2kg (5lb).

Welsh Mountain Ewes hornless, rams horned. Wool short and variable in quality. Face white. Live 40kg (88lb), fleece 1.3kg (3lb).

South Wales Mountain Ewes hornless, rams horned. Wool short and coarse. Face and legs white. Live 50kg (110lb), fleece 1.4kg (3lb).

SEASHORE SEAWEEDS

Seaweeds prosper along our rocky shores, in rock pools, gulleys, estuaries, on rocks and shingle and even in sewage outlets. At low tide, especially, you can find a marvellous array of different species in muted shades of brown, green and red.

Two species of oarweed, *Laminaria digitata* and *L. hyperborea* exposed at low tide at Elwst in south Wales. Oarweeds are some of our largest algae.

Although many flowering plants grow near the seashore, only the three species of eel grass are truly marine species. All the other dominant species of the lower shore and sea bottom are algae, a large group of plants which range from small bacteria to seaweeds up to several metres long.

Seaweeds provide respite from the pounding of the waves, offering all kinds of marine creatures shelter, dampness and something to cling on to when the tide is out. They also provide nourishment for some living creatures.

The 800 or so species of seaweeds found around the British Isles have an enormous variety of shapes and colours. All contain the green pigment chlorophyll, and you'll therefore find them growing in areas where, for at least part of the time, they are exposed to the light which is essential for photosynthesis.

Seaweeds are classified according to their colours–brown, green and red. Brown seaweeds need direct light and are often found high up the shore. Green seaweeds too need a good deal of light and usually grow high up the shore near fresh water. Red seaweeds, on the other hand, survive well in rock pools and below the tide mark because the red pigments enable them to absorb light particularly efficiently.

Brown seaweeds are by far the most conspicuous species. Oarweeds (kelps) are anchored by a branched holdfast to the sea bottom or rocks, as deep as 30m (100ft), sometimes forming dense underwater forests. *Laminaria digitata* is one of the most common oarweeds. At low tide it lies flat under any available water to avoid drying out. Another plentiful species, *L. hyperborea*, remains semi-erect at low tide. Numerous other seaweeds, as well as marine creatures find shelter in the tough fronds of oarweeds.

Rainbow bladderweed gets its common name from its beautiful blue-green colour under water. It often grows with wrack species, such as saw wrack and bladder wrack, two of our most robust wracks that have branched strap-like fronds. Bladder wrack and bladderweed gets its name from the numerous air sockets in the fronds which keep it afloat.

Green seaweeds There are relatively few species of green seaweed growing around the shores of the British Isles. Sea lettuce has delicate green fronds which form slippery carpets over the rocks. It tends to grow on the upper shore, often near sewage outlets or rock pools. It is edible, but needs careful washing and, like all seaweeds, is rich in nutritious trace elements. *Codium tomentosum* is another dark green species with much-branched cylindrical fronds that grows on rocks and in pools on the middle and lower shore.

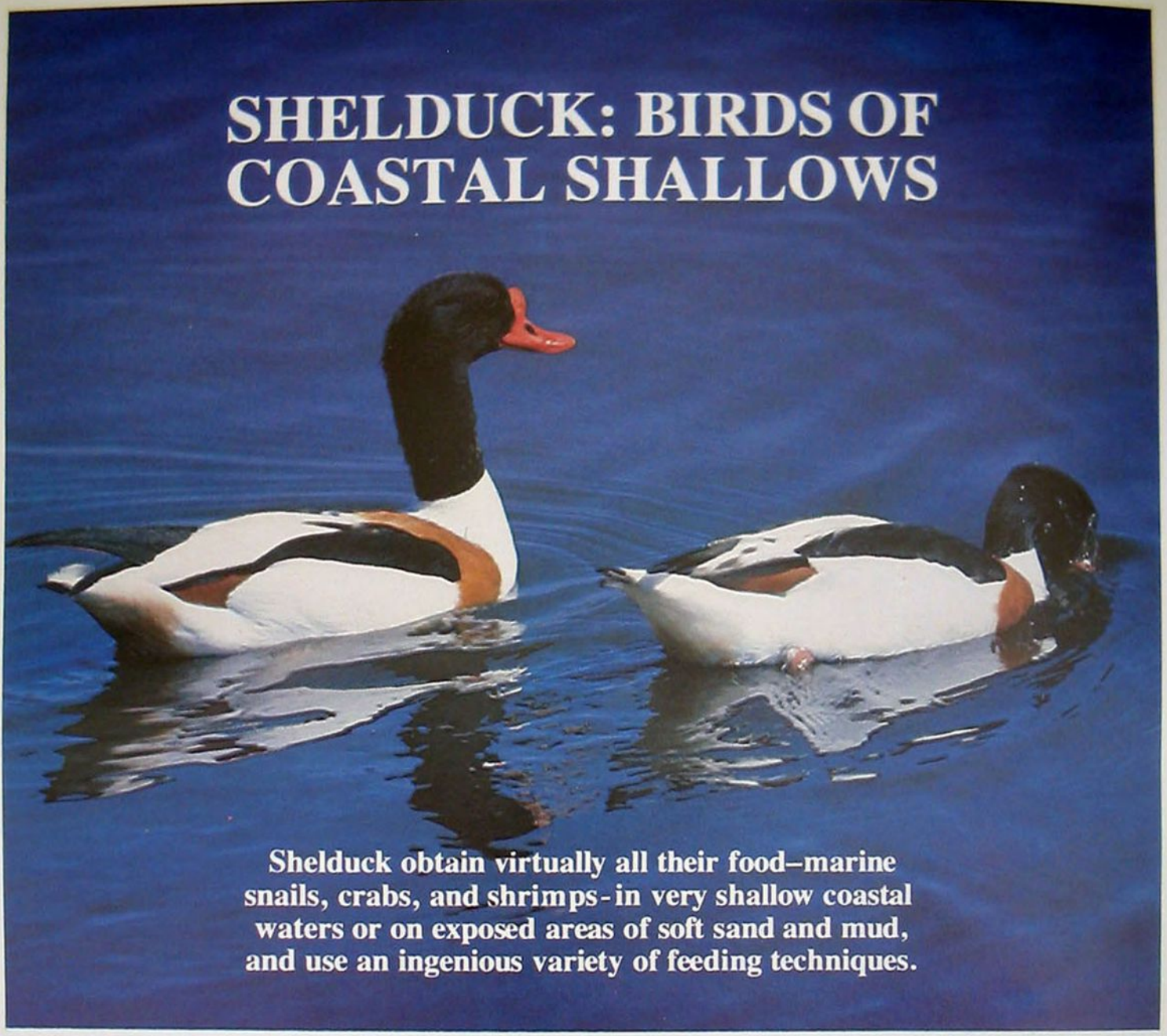
Red seaweeds There are more species of red seaweed on the shore than greens or browns, but as most of them are small and delicate you have to search hard in rock pools or on other weeds. One of the most common is carragheen, a reddish-purple species that turns green in bright sunlight. It thrives on lower rocky shores or among shingle. Its tough fronds, each one up to 8cm (3in) long, grow in fan-shaped clusters piled on top of one another in cushions up to 15cm (6in) thick. During summer the fronds may be covered with dark spots which are the reproductive spore cells.

At one time extracts of carrageen were mixed with lemon or cocoa as a remedy for lung ailments. It is still widely used commercially to make vegetable gelatines. In south Wales it is used to make laverbread.

Above: A variety of seaweeds growing in a gully in Jersey, a particularly hospitable habitat to numerous algae. From left to right: *Codium tomentosum*, a green species; Rainbow bladderweed (*Cystoseira tamariscifolia*), Saw wrack (*Fucus serratus*) and Bladder wrack (*F. vesiculosus*), all brown species.

Below: Carragheen (*Chondrus crispus*) growing with Sea-lettuce (*Ulva lactuca*).

SHELDUCK: BIRDS OF COASTAL SHALLOWS



Shelduck obtain virtually all their food–marine snails, crabs, and shrimps–in very shallow coastal waters or on exposed areas of soft sand and mud, and use an ingenious variety of feeding techniques.

Above: Midway in size between a duck and a goose, shelduck are mainly white birds with a dark green head, a distinctive, broad chestnut band round the chest, black flight feathers and black bars on the back, belly and at the tip of the tail. The bill is red, and the legs and feet are pink. The sexes are fairly similar, (much more so than, say, the mallard–see page 292).

Shelduck (*Tadorna tadorna*), 60-65cm (2ft) from beak to tip of tail; wing-span 110cm (about 4ft). Adult male weighs about 1.2kg (2½lb) and is slightly larger than the female. Distribution coastal resident, migrates to moult.

Shelduck are found almost exclusively on the coast, in muddy estuaries and along sandy shores, rarely occurring far inland. In some of our larger estuaries, there are flocks of several thousand, but even the smallest bay or river mouth may have anything from ten or twenty to several hundred of these birds.

Large flocks Shelduck are very gregarious birds, living in large flocks throughout the autumn and winter. In the Wash, for example, as many as 20,000 have been counted in mid-winter, while flocks of over 5,000 occur regularly in the Mersey estuary and on the nearby Dee in Cheshire. In the middle of the winter, the total British population numbers around 70,000. This is about half the north-west European population which is distributed from the Baltic through Germany, the Netherlands and down the coast of western France. Probably about 15,000 pairs breed in Britain and Ireland.

Forming pairs Despite the large flocks, there is usually no aggression between the birds in the rivalry for mating pairs. As spring approaches, pairs begin to form and disperse to their breeding territories. If both members of a pair are still alive from a previous year, they will go together to their same territory. If the female alone is alive she goes to her old territory, taking her new mate with her or finding one there.

Pairs are formed through the ritual of courtship, with several males trying to attract the attention of a single female. Up to eight or more males may gather round one female who then takes flight, followed by all her suitors. Each male tries to catch up with, and fly alongside, the female, who flies in wide circles, not really trying to get away, but clearly trying to avoid being too crowded.

There is much calling at this time–the male has a soft, single or double noted whistle, while the female uses a much harsher 'gagaga' call, which can be heard far and wide. The courtship flights may continue for several minutes, with periods of direct

flying interspersed with much gliding and calling.

Once a pair has been formed, the bond is reinforced by several different displays, particularly by the male. For instance, the male may raise his head and neck straight upwards pointing his bill to the sky, while emitting a whistle. Another display in which the head and neck are bowed low to the ground, is often followed by an attack on an intruding bird. Both sexes also indulge in the ritual of preening themselves behind slightly raised wings.

Feeding and nest sites Once firmly paired shelduck adopt a feeding territory on a suitable part of the estuary or shore, and defend it against other shelduck pairs also setting up territories. This feeding territory is maintained throughout the egg laying and incubation periods which follow.

The actual nest site may be some distance away on the land, and does not have a defended territory around it. The nest is generally in a hole of some kind–a rabbit-hole in sand dunes or in an old seawall is common. Holes in haystacks, hollow trees, or even under buildings are all used and, exceptionally the nest may be sited in dense vegetation. In some areas shelduck have taken readily to nest-boxes dug into the ground; this has helped breeding populations to increase where natural holes were becoming scarce. Shelduck cannot excavate their own holes, though it has sometimes been stated that they can. Nor do they add any nesting material, though they may arrange existing straw or vegetation into a nest cup, and then line it with copious quantities of soft grey down in readiness for the female to lay her eggs.

The average clutch, which the female incubates, is eight to ten eggs. While the female incubates, the male continues to

Above: Shelduck walk and run easily, and take flight readily from land or water, sometimes taking a few preliminary steps. In flight they are more like a goose than a duck–not particularly fast, but with steady powerful wing-beats.

Searching for food

The shelduck principally eats small molluscs–particularly a small marine snail called *Hydrobia* which occurs in great abundance in some estuaries–and crustaceans including small crabs, shrimps and sandhoppers. This duck also feeds on seeds of water plants, the spawn of fish and various small worms.

The shelduck has developed a number of different ways to search for food–each adapted to the abundance of prey, the state of the tide and the condition of the mud. In fairly hard, dry mud or sand, the bird digs with its bill **(1)**, perhaps first locating its prey by some small signs on the surface. Where the mud is soft and oozy, the shelduck 'scythes' **(2)**, moving slowly forward with the tip of its bill submerged in the mud, all the while swinging its head to and fro. This technique brings its sensitive bill tip into contact with the maximum volume of mud in which it can locate whatever prey is living there. This scything also leaves behind a distinct track in the mud rather like an extended fern leaf. You can see such tracks as you walk over mudflats. When feeding in shallow water, the shelduck dabbles with its bill, often forming shallow craters all over the mud surface. It also paddles vigorously with its feet, either in the shallow water or in soft mud; this helps to bring its prey closer to the surface. Finally

as the tide rises and the bird needs to carry on feeding, it resorts to dipping its entire head under water, or even up-ending **(3)**, where it can probably reach down to 20 or 30cm (8 to 12in). By using all these different feeding techniques, the shelduck prolongs the period in which it can search successfully for food. It only ceases activity when the tide is at its highest, returning to feed again as soon as the tide retreats.

defend the feeding territory down on the shore; the female joins him there to feed three or four times a day, generally for 20 minutes or so. As these are the only feeding opportunities which she has during the 30-day incubation period, it is vital to her that this secure feeding area is maintained by the male. The female can then spend the whole of her brief off-duty spells feeding in safety.

Journey to the nursery Once the young have all hatched, the female and male lead them to a nursery area. This is usually in a completely separate part of the estuary or shore from the now abandoned feeding territory. Some shelduck nests are up to one or two kilometres inland and the brood can have a fairly difficult journey to the sea, with some chicks getting stuck in ditches and behind fences. Surprisingly, this does not appear to worry the female parent when she is selecting a nest-site.

In the nursery area the young feed themselves, but are defended by the parents who also brood them at night or in rainy weather. Such behaviour is quite normal among the larger waterfowl, but in the case of the shelduck this period of a full parent-young bond is comparatively short-lived. After only a week or two the broods begin to amalgamate into creches, which may be up to 100 strong. Most of the brood amalgamations seem to take place when adjacent broods come together naturally while feeding; but sometimes there is a squabble between neighbouring parents during which the young scatter, and then do not return to their correct broods.

At the same time that this is going on, most of the adults are beginning to lose interest in their young. Usually one or two adults accompany a creche, but sometimes there are none, and in areas where only

Above: Shelduck eggs are creamy white. The nest can be near muddy water, or in a hole some distance inland. Below: One good way to tell the male from the female is by the knob at the base of his bill. The female's bill lacks this conspicuous knob.

single pairs breed, the broods are abandoned altogether. The adults which do stay with the young are usually birds whose young are in the creche. For the rest the adult-duckling bond appears to break completely, and the young cease to recognise their parents, or to need them in any way. They can by now look after themselves, and often the broods or creches huddle together at night for mutual warmth, instead of being brooded by the adults.

Loss of flight feathers The vast majority of adult shelduck then leave the breeding grounds altogether, and set off on a migration to a special area where they spend the period of the annual feather moult. Like all wildfowl, shelduck lose all their flight feathers at once and so become flightless for a period of about three weeks while new ones grow. (Most other birds shed their flight feathers one at a time over a long period.) During this flightless period shelduck need a secure area where there is plenty of food, and freedom from predators. This they find in the Knechtsand, an enormous area of shallow sea and sand-flats off the German north sea coast, around the mouth of the river Elbe where North Germany meets Denmark.

The first birds to arrive at the Knectsand are the immature non-breeders. Shelduck do not breed until they are at least two years old. The one-year-old birds leave the breeding grounds in late June and set off for the moulting area. They are followed by successive waves of adults, so that by late July or early August tens of thousands of shelduck have gathered to moult. They stay here for the duration of the flightless period, and often for several weeks afterwards, before gradually dispersing to return to their winter quarters.

For many years the Knechtsand was thought to be the sole moulting area for shelducks from north-west Europe, but about 25 years ago a small moulting population of about 3000 birds was discovered at Bridgwater Bay in Somerset. Here the conditions were similar to those in the North Sea, with safe, shallow seas and plenty of food. From the timing of the arrival of these birds it was thought that they probably came from breeding areas in Ireland, thus saving themselves the much longer flight to the Knechtsand. In recent years a few more smaller moulting sites have come to light, including the Wash, and the Firth of Forth, though only a few hundred birds use either.

Moult migrations, as such special movements are termed, occur in many species of wildfowl but none is as complete–involving such a high proportion of the total population –as in the shelduck.

In most cases it involves just the non-breeding birds, or perhaps the males of those species in which all the brood rearing is done by the female. The result, though, is the same in each case. The food reserves of the breeding grounds are made more available to the growing young birds by the absence of many, or all, of the adults. The latter move away to an area with ample food supplies which they can exploit. The young, which are not able to fly yet, are left the maximum amount of food and the minimum amount of competition for it.

The young shelduck has a grey-brown crown and back, a whitish face with a pinkish bill, and grey legs. It becomes fully independent after about two months and, like the adult, it searches the seashore for small molluscs, crustaceans and other creatures that live in the upper few centimetres of mud and sand.

Above: The mother takes her young on their journey from the nest site to the feeding area, which the male is defending. The two sites may be several kilometres apart.

Below: The immature juvenile is instantly recognisable by its beak, which lacks the colourful red of the adults. Its body plumage is also duller, with no chestnut band.

SURVIVAL ON THE COASTAL CLIFFS

Carved by the restless elements, the cliffs are the front line in the battle between sea and land. Although survival in the tough conditions is strictly for specialists, the cliffs have an advantage for wildlife – they are left alone by man.

A cliff face provides a rare opportunity to see the rocks that lie beneath the springy seaside turf. As the sea eats relentlessly into the land a cross-section of the landscape is laid bare for people to admire and for hardy creatures to colonize.

These frontier habitats are as varied as Britain's remarkably varied geology. A wide range of rocks is displayed where the coastline interrupts the geological formations. Differing rates of erosion produce, for example, towering cliffs of great resistance, crumbling sandy cliffs, gleaming walls of white chalk, slips and slumps of all descriptions. Cliff-land habitats are infinitely variable, but all are vulnerable to the sea and

share a particular sense of remoteness.

Standing room only Because the cliffs vary so much in material and in structure, no community exists which is typical of all cliffs. The image of cliff life is probably best evoked by the clamouring colonies of seabirds which come to our shores in spring to breed. They tend to favour the north and west coasts.

Birds which spend a great part of their lives in the remoteness of the oceans choose remote, inaccessible places to breed. Different species have different requirements for nest sites, and this produces a pattern in their distribution. The guillemot, for example, Britain's most numerous seabird, breeds in colonies on vertical or near-vertical cliffs. Narrow ledges along the cliff face provide suitable nest sites for these chocolate-brown birds with white fronts; they stand shoulder to shoulder, each one incubating a single egg. The guillemots, members of the auk family, make their living at sea as underwater fishermen, and when ashore they have no reason to move around. So the rather basic accommodation offered by these ledges is all they need.

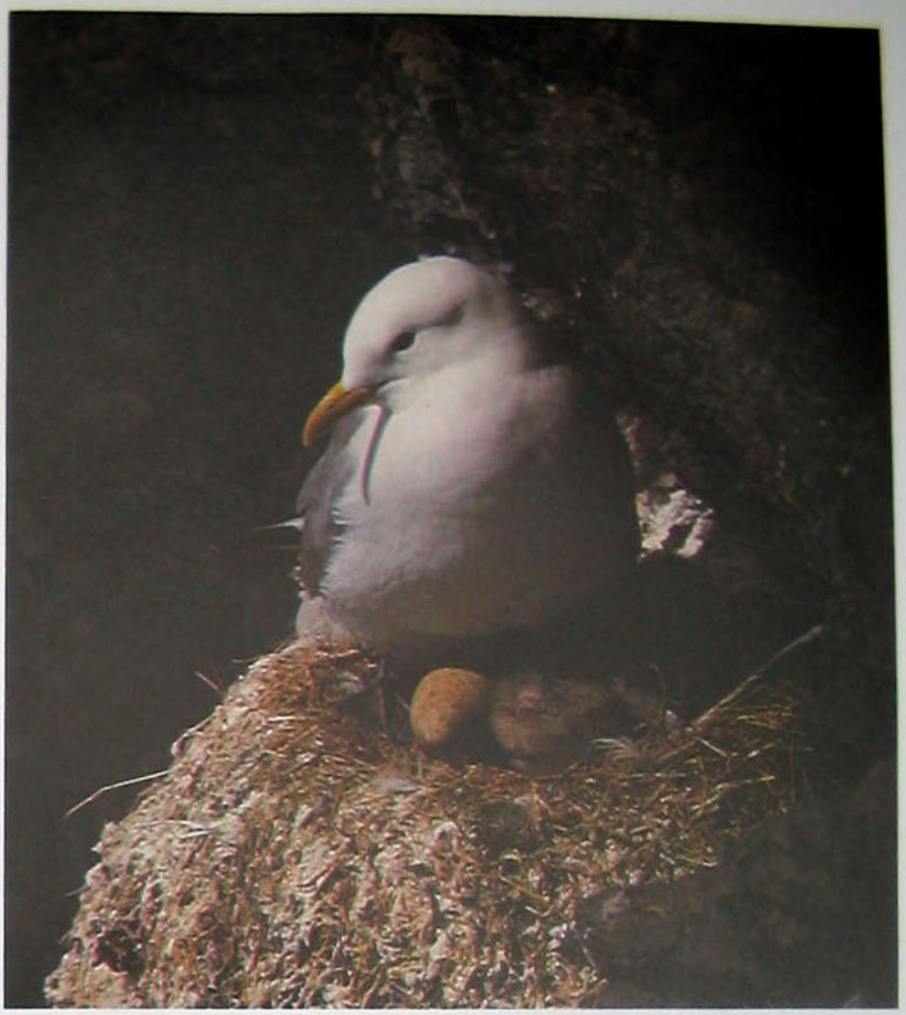
No nest cradles the guillemot egg, which is pear-shaped and therefore relatively safe from rolling over the edge: any accidental movement causes it to spin on the spot, rather than to roll over the edge. When the chicks are two or three weeks old they launch themselves straight into the deep sea below.

The razorbill, a relative of the guillemot, looks similar but is black instead of brown and has a thinner, deeper bill. It chooses cliff areas that have rock tumbles and caverns, often including an overhanging roof. The razorbill too lays a single egg, but without the anti-roll design.

Safety in numbers Colonial nesting offers the auks real advantages. It gives the individual a better chance of escaping from predators, especially the young, who frequently hatch on the same day and take to the sea together; few stragglers remain to be picked off by the crows.

The fulmar, another seabird of the deep ocean which resorts to the land for breeding only, has less specific nest-site requirements. The species has increased dramatically in numbers and distribution over the last 200 years. The single white egg of the fulmar may rest on a bare rock ledge or, in softer cliff material, the female sometimes scrapes out a hollow or utilises a pocket eroded by the wind. The incubating parents (both sexes) sit for long periods between changeover, and the fat fluffy white chick also sits around for a long time–another six to eight weeks–being fed by the parents from the bountiful sea nearby.

By late summer these seabird visitors of the cliffscapes have left, the fulmars and kittiwakes dispersing on the wing to their ocean feeding grounds, the auks swimming off to open waters using the powerful paddle feet which are of so little use on land. Their brief presence inevitably affects the character of the cliff faces for those creatures which remain.



Above: The kittiwake plasters a nest to the sheer cliff face, sheltering its eggs (usually two) in a well-formed cup where the chicks remain until they fly at about six weeks old. The kittiwake is our most maritime gull and with its plastering technique it can colonize ledges that are too narrow even for guillemots. The two species are often neighbours on the same cliff face.

Permanent residents The plants which colonize this battleground between land and sea cannot move to warmer climes when breeding is done, but must complete their life-cycles in the teeth of gale-blown spray, the scorching heat of summer sun, come rain, snow, frost or landslide.

The land plants that creep closest to the sea itself are lichens of the splash zone, some forming bright patches of brilliant colour. The moisture they retain may pave the way for other plants, but most cliff species rely on a crack in the rock to provide a first foothold; larger crevices may shelter a richer plant growth. Rock samphire, for example, is a typical plant of rocky cliffs at all heights, often springing from a tight crack with no apparent soil–its long tough root tapping deep moisture and tolerating a high degree of salinity. The dainty thrift and sea campion, too, have long, probing roots.

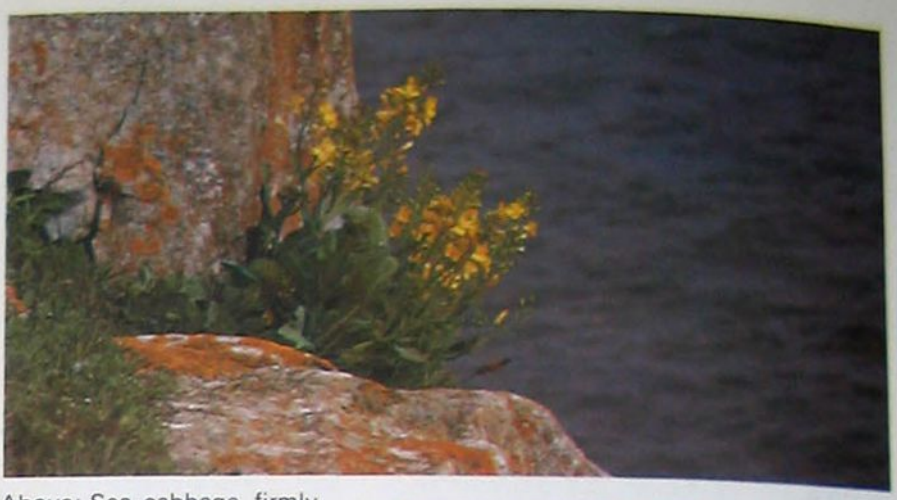
Cliff hardships When fresh water is available it is often in excess, washing downwards in rivulets which sweep seeds, rock and soil, and whole plants to the inhospitable sea below. Such instability favours plants which are especially quick to colonize newly broken ground, for example sea beet.

Facing page: This headland on Great Saltee Island in western Ireland is visited by both guillemots and kittiwakes. You can also see the pink cushions of thrift near the top, and the white clumps of sea campion. Yellow *Xanthoria* lichens clothe the drier sections of rock higher up, while lower down a black coating of *Verrucaria* lichen is marked with white streaks of guano.

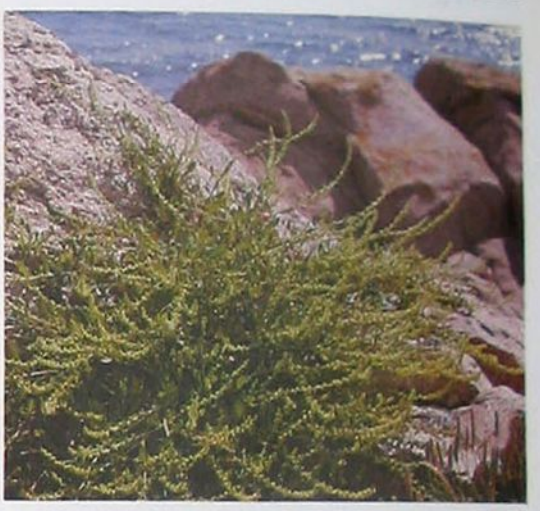
A rock fall may create a new habitat overnight. In the breeding season the birds, too, make great changes to their environment which naturally affect the plants. Severe trampling and guano production around the breeding sites kills all plant life, but moderate manuring with bird droppings creates the right conditions for sea campion to thrive, and tree mallow which grows more luxuriantly amid the jumble of herring gull and cormorant nests.

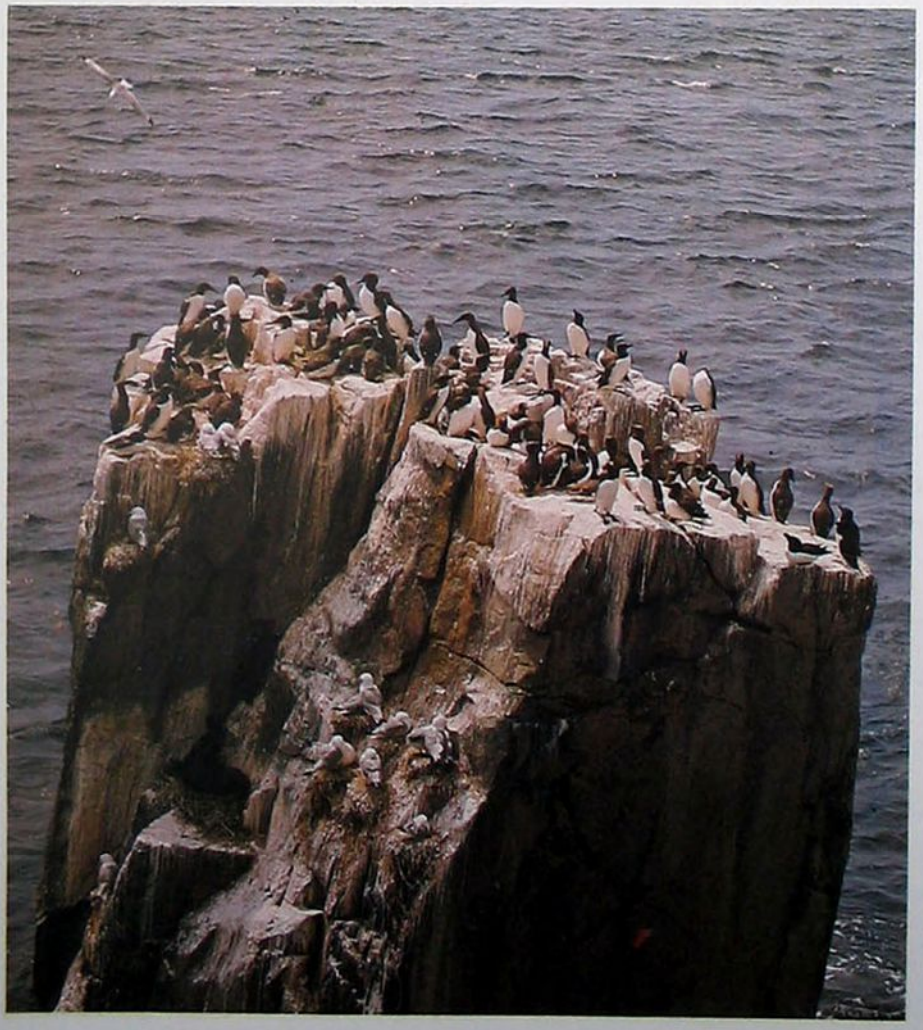
Puffins trample the ground and lay it bare at the entrances to their cliff-top nest burrows; but when the breeding season ends and the puffins take to the sea, annual plants such as chickweed take root for their short life.

On the cliff face, a major hardship for plants is lack of water, and many survive only by being equipped to conserve water by means of fleshy leaves or stems, waxy cuticles and low, ground-hugging forms. On the cliff tops other battles must be fought–with plant competitors; the outcome is often determined by rabbits, whose choice of plants for grazing is all-important. Thrift grows better when its competitor, the vigorous grass *Festuca rubra*, is kept down by rabbits. Not only do they eat the grass but they burrow underneath it, removing the soil that acts as a moisture reserve. This harms the short-rooted grass more than it harms thrift, which has roots that can reach as far as a metre down.



Above: Sea-cabbage, firmly rooted in a crevice.
Right: Sea beet has a mass of spreading runners that make it a rapid colonizer of newly broken cliff surfaces. Its leathery look belies the tender tastiness of this wild relative of spinach.
Below: A rocky stack close to Inner Farne off the Northumberland coast. For the guillemots on top it is ideal for they need sheer cliff faces from which to plunge into the sea. Kittiwakes and shags are nesting on the lower ledges.





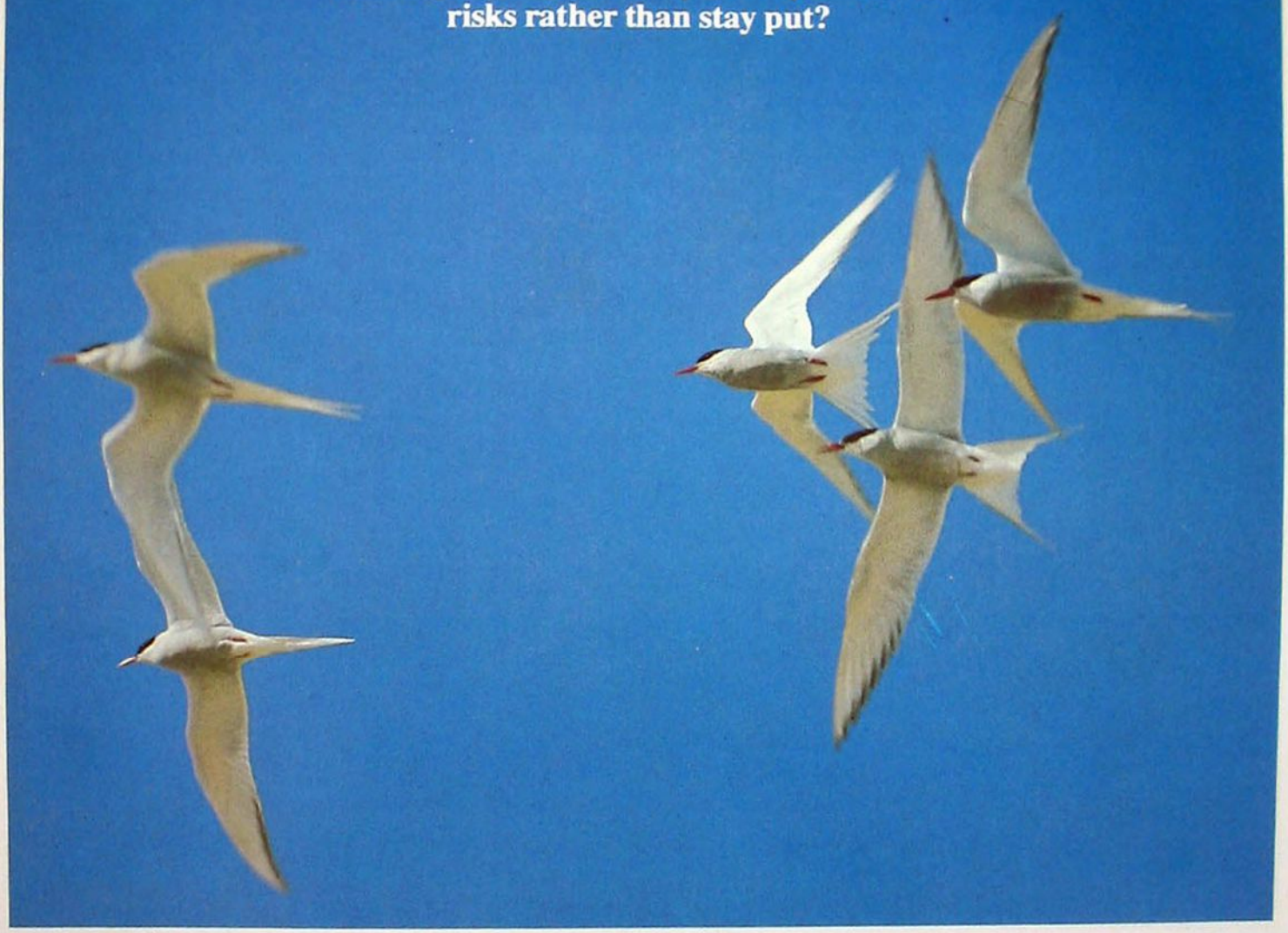
The cliff community As the rabbits affect the plant community, so all plants and animals of the cliffs help to build their own landscape, feeding on each other, manuring the land and spreading seed. Some creatures are resident, some just visit, but many roles are acted out here. The role of predator is played magnificently by the peregrine which nests in remote cliff holes or ledges. The peregrine may take rabbits, but it is the continuous supply of seabirds and pigeons which sustain this falcon, now recovering after a period of dangerously low numbers.

The remoteness of the cliffs favours ravens, too: much persecuted in the past by gamekeepers inland, they lead less troubled lives on the wild cliffs of the west and north where they build their monumental nests on inaccessible ledges. The chough, another cliff-land crow, is far from common. A choosy eater of insects, its numbers have declined and it is now confined to the cliffs and caves of the Inner Hebrides, Isle of Man, Ireland and Wales.

For people, cliff tops make superb vantage points from which to watch perhaps the soaring and wheeling of fulmars, or seals bobbing in the sea below. On sheltered ledges, lizards bask on sandy slopes, sand martins scoop flying insects from rising thermals. But cliffs are more often harsh and forbidding places where the colonists are hardy and well adapted.

TRANSCONTINENTAL BIRD MIGRATIONS

Single migrations of over 6000 miles seem to us to be beyond the capabilities of such small birds as swallows and willow warblers. But billions of these birds make vast trips each year. Why do they take such risks rather than stay put?



Those birds which migrate, rather than remain at home, do so for one simple reason – to find food. Birds which breed in the far north in summer come to spend winter in Britain because there is no food available in their Arctic breeding grounds. (In the Arctic tundra in summer there is a short-lived flush of insect life which, together with other sources of food, sustains the birds while they mate and raise young.) In the same way, there is not enough food in Britain in winter to supply most of our insect-eating birds. Such aerial species as swallows (see page 132), swifts (see page 349) and martins have almost no chance of finding flying insects to feed on during the winter. Similarly, the warblers and flycatchers that depend on arthropods which are plentiful during the warmer months, cannot rely on them being available during the winter. These birds therefore move south to winter in the tropics.

Perhaps the most interesting question is why do they ever return from their winter home – where there is plenty of food and nesting space? The answer is that there is a wide variety of local birds – including several species of swallow, for instance – that are specially adapted to a year-round existence in the tropics. There is no chance of a vast number of northern birds being able to breed and compete successfully for food in such a network of tropical species.

Above: Arctic terns are the longest distance migrants of all birds. Those that breed north of the Arctic circle spend winter close to the Antarctic pack ice and so experience continuous daylight for up to eight months of the year. Several Arctic terns from Europe have been reported from as far away as Australia.

Summer migrants (birds that come to Britain in summer.)
Swallows winter furthest south in Africa. Route northwards in spring just east of southern route in autumn.
Swifts in Britain only in May, June and July. Winter in Malawi.
Lesser whitethroats winter in east Africa. Intermediate fattening area in northern Italy, also call in on Nile Delta.
Whitethroats migrate south-south-westerwards. Autumn fattening area in N-W Spain; winter in Sahel region of W Africa.

Seabird and wader routes (not illustrated).
Knots reach Britain from Greenland and Canada.
Manx shearwaters winter off Brazil.
Gannets migrate further as juveniles than adults, to tropics and Mediterranean.
Ruffs from E Siberia to Britain, winter in W Africa, return via Italy.

To feed or fly away During the winter months, British birds have two options: sit it out or move southwards. If they remain they must either exploit a new food source, or a specialised feeding style which allows them to feed in the same way. In the first case, species like the blue and great tits feed during the winter on dormant insects and their eggs that are hidden in the bark of trees, or on different foods like the tor . of peanuts fed to them by bird-lovers. In the second case, birds such as wrens and dunnocks remain here, feeding largely on the arthropods which they prize out from shelters in thick cover.

Network of routes The journeys that bird migrants make vary enormously. Many people think of bird migration as something which just concerns swallows from Europe reaching southern Africa; but this is only a minute part of the web of migration woven round the British Isles. Not only do our summer birds leave here to winter in warmer areas, but our islands also play host to millions of birds spending their winters with us. The geographical position of the British Isles on the western flank of Eurasia, with the warming influence of the Atlantic and the subtropical water brought north-east to our shores by the Gulf Stream, makes them a welcome refuge for many species of waterfowl which spend their summers in Siberia.

The distinction between migratory and sedentary species, is not clear-cut because there are continental populations of many resident British birds which are themselves migratory – some of them, like starlings and blackbirds, reaching Britain as winter visitors in large numbers.

Timetables of flights The timing of migration is crucial; in spring returning birds cannot afford to arrive too early. They would starve on arrival if their food supply was not available. On the other hand the individuals which arrive first, and manage to survive, are able to occupy the best territories.

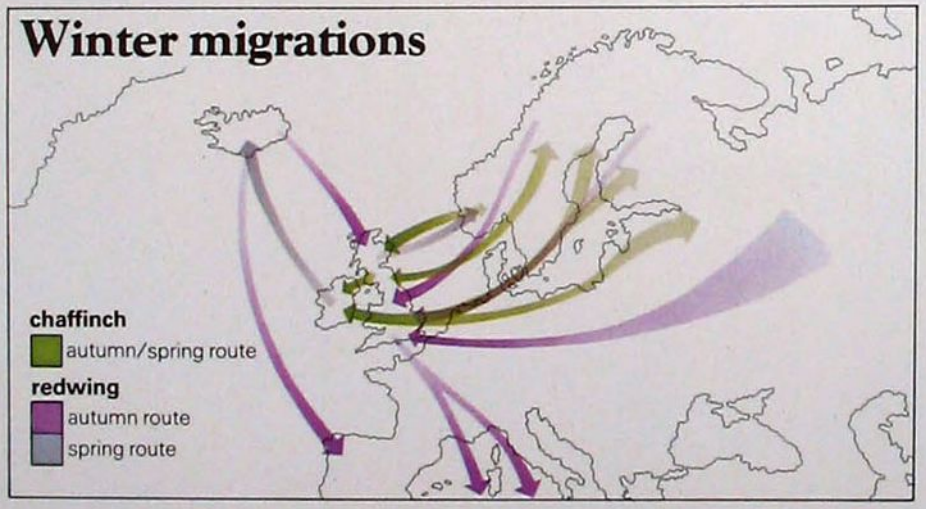
In most bird species the males arrive first so that they can mark out territories and then attract the females to them. On the other hand some species, particularly ducks and geese, pair off in the winter quarters and migrate to the breeding grounds together. Sometimes the ducks which pair in the winter originate from very different areas but, once joined together, one will follow the other to unfamiliar territory. This phenomenon – called abmigration – accounts for some puzzling recoveries of ringed British-bred ducks in central Russia during the breeding season.

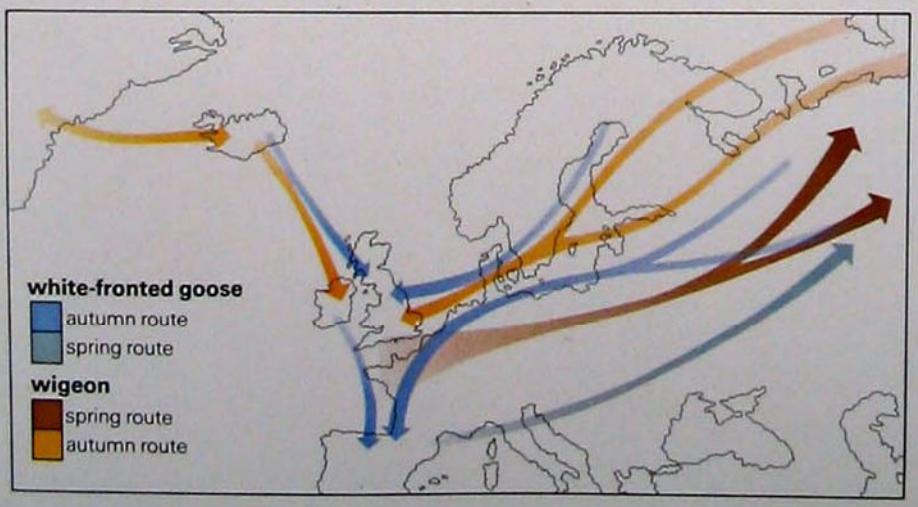
The main activity for most birds, which starts immediately they come to Britain in summer, is breeding. But for many birds this is followed by another crucial period – the annual moult – when they renew all their feathers. The timing of the autumn migration is also crucial: for the adult birds, the moult follows the busy breeding period, and for the young birds the autumn pre-migration period determines whether they will be able to build up their strength and survive.

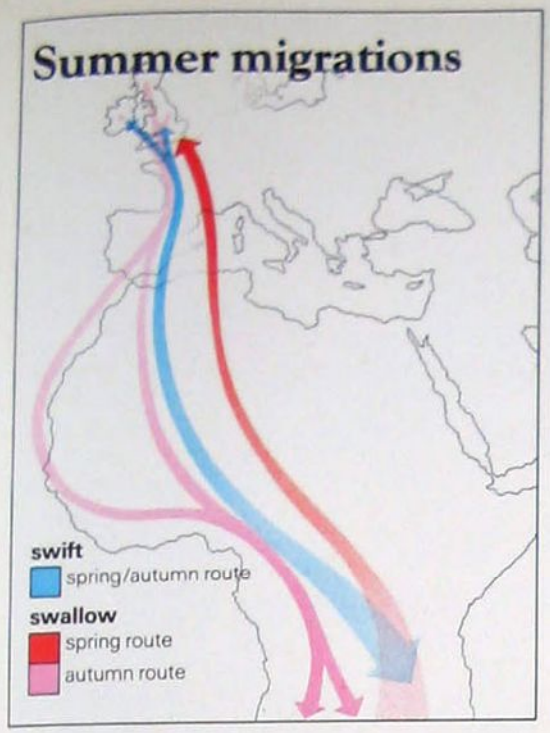
Daylight trips Those birds that make their journey in daylight are called diurnal migrants. Generally the diurnal migrants make their trips in rather short bursts of a hundred or so miles at a time. Often their routes are greatly influenced by the local landscape, the birds funnelling through mountain passes or across short stretches of sea. In the British Isles the autumn flights of finches, meadow pipits and skylarks down the east coast, and the flights of geese up the mountain passes of Scotland, are an unforgettable sight.

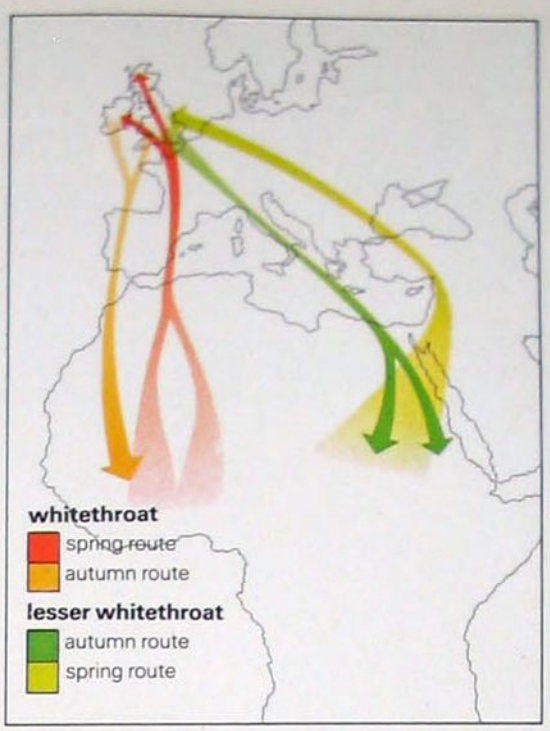
These concentrations of diurnal migrants are responsible for the enormous congestion of soaring birds at the Straits of Gibraltar and the Bosphorus each autumn. Hundreds of thousands of white storks and birds of prey congregate at these places each year. Falsterbo, in southern Sweden, provides another concentration point for migrants moving southwards from Scandinavia. Britain is not endowed with such spectacular sites, but you may see high numbers of diurnal migrants at many south and east coast headlands during the autumn – Portland Bill and Selsey Bill, Beachy Head, Dungeness, Gibraltar Point and Spurn Head are all good vantage sites.

Night-flights Those bird migrants that travel at night – nocturnal migrants – are not always as easy to see when they migrate; but you can infer their movements by watching









Winter visitors (to the British Isles).
Wigeons wintering here breed across Scandinavia into Siberia.
White-fronted goose in Ireland and west Britain come from Greenland; those in south and east England (also Slimbridge) are from northern Russia.
Redwings, common birds in Britain in winter, come from Iceland (where there is a distinctive species *colurni*), and from Scandinavia and Russia. Many travel even further south to Spain, Italy and as far as Greece and Turkey.
Chaffinches resident here have brick-red underparts.

any suitable area and recording the fluctuating numbers. This is particularly easy on offshore islands or coastal headlands where migrants that would never normally be seen in such barren areas may appear in large numbers. Bird observatories dotted around the country, have been operating for up to 30 years and carefully record the birds which pass through. Their records show what the common birds do each year as well as the activities of rare visitors.

In contrast to the short steps generally made by the diurnal species, nocturnal migrants may fly non-stop for more than three days–in some cases regularly for 80 or even 100 hours. With an air speed of about 25 miles per hour this means that many can fly 250 miles in one stretch. The birds which do this, such as sedge warblers, store fat under their skin (subcutaneously) to use as fuel on their flight. They may well double their weight before migrating. Sedge warblers take off from southern England in the autumn weighing about 22g ($\frac{3}{4}$oz), fly for four days and land in Senegal, south of the Sahara, four days later weighing about 10g ($\frac{1}{4}$oz). Other species, like the closely related reed warbler, do not make such long single trips, but stop off on the west coast of Portugal to refuel.

How do they navigate? Such long journeys are not without their hazards. Even if the bird has fuelled up adequately it must still be able to find its way properly. Birds navigate by referring to the sun, stars (which implies some sort of in-built timing mechanism) as well as to the earth's magnetic field. They also rely on an inbuilt homing device to give an indication of direction. They have evolved their migratory routes simply because these routes work. It is certain that the newly hatched warbler, for instance, has within its genetic make-up the information it needs to accomplish its migration.

Perhaps the one aspect that makes bird migration such a fascinating part of ornithology is the tremendously varied habitats that one individual bird visits and lives in during its year. For example, the Black-headed gulls which take bread from the tourists on Westminster embankment include individuals bred on marshes in Poland, Czechoslovakia and Scandinavia. The swallow nesting in your garage may have been feeding among the debris of a South African gold-mine last winter, and will have passed over the vast expanse of the Sahara during March.

Above: House martins congregate on telegraph wires, before migrating on the long trip to their wintering quarters in Africa. Our best known migrants, the swallows, also do this; and both species, which find ample supplies of insects to catch on the wing in summer, migrate in winter rather than attempt to exploit different food sources.

DRAGONFLIES

Dragonflies – brilliantly coloured, sun-loving insects with transparent wings – are fast-flying hunters that spend the summer darting over ponds and streams in search of prey.

Dragonflies, together with their close relatives the damselflies, belong to an order known as the Odonata. All of them are predators throughout their lives and have aquatic larvae, frequently called nymphs, and they are regarded as being among the most primitive of winged insects.

Dragonflies can be distinguished from damselflies by their more robust build and usually larger size, and by the way in which they hold their wings when at rest. In dragonflies the wings are extended horizontally on each side; damselflies hold their wings together over their backs just as butterflies do.

The two pairs of wings are usually colourless and transparent, their membranes supported by a fine network of 'veins' quite unlike those of any other insects. This is one of the characteristics regarded as primitive. Another is the direct and simple way in which the muscles of the thorax move the wings up and down; they are attached on each side of a pivot at the base of the wing, so that the outside muscles pull the wing down and those inside the pivot pull it up. The higher insects, such as the bees, flies and butterflies, have mechanisms that are far more complicated.

Dragonflies also have an immensely long geological history. At the time when our coal was formed, about 300 million years ago, their evolutionary ancestors were already flying in the great swampy jungles; some species had a wingspan of nearly 70cm (27in) and were the largest insects known to us. True dragonflies not unlike those of today appear in the fossil record of about 250 million years ago. If you consider that the entire reign of the dinosaurs lasted from about 200 to 65 million years ago, you can realise what an immensely long innings the dragonflies have had.

Above: A male hawker dragonfly, *Brachytron pratense,* of the Aeshnidae family. Members of this family have a wingspan of up to 10cm (4in) and are generally out and about in summer. The female hawker dragonfly lays its eggs in the stems of water plants or in moss beside ponds or streams. The larvae, which are large, have elongated, torpedo-shaped bodies. Any clear, fairly still water with plenty of water weeds provides breeding quarters for hawker dragonflies, and most of them have a life cycle lasting two or more years.

Adult dragonflies have the lifestyle of falcons, hunting and catching other insects on the wing. To do this they must be fast, active flyers–which they are, despite the archaic design of their wings. The legs of dragonflies are arranged so that, when spread out, they form a forward-directed basket or net which is used in capturing flying prey. A dragonfly can rest by clinging on to a twig or grass stem with its feet, but can walk only in a slow and awkward manner.

Dragonfly larvae, or nymphs, also capture prey. Most insects have a segmented organ, called the labium, below the mouth. In dragonfly larvae this is elongated and hinged so that it can be extended in front of the head, and it bears a pair of pincer-like claws near the tip. It is sometimes referred to as a 'mask'. A hunting larva stalks its prey to within a centimetre or less, then shoots out the labium and seizes the prey with its claws. The victims are mostly water insects, but large, well-grown larvae kill small fish, and are most unwelcome in trout hatcheries.

The larva's breathing mechanism is rather peculiar. It has gills inside the rectum and water is drawn in and out to aerate them. The water can be forcibly expelled, causing the larva to shoot forward if threatened by danger. This combination of breathing and jet propulsion is a feature shared by the marine squids and cuttlefish.

The dragonfly larva's life is usually long. Some Libellulid species may complete their life cycle in a year, but most of the other dragonflies spend at least two years in the water, and some spend as many as five years.

Darters and hawkers There are 27 species of dragonfly in the British Isles, most belonging either to the Aeshnidae (hawker) family of to the Libellulidae (darter) family. The names 'darter' and 'hawker' come from the different habits of flight of the two families of dragonflies. Darters fly quickly out from a perch in waterside vegetation, returning to it again just as rapidly, while hawkers have a stronger, sustained flight.

The most frequently seen are probably the darters of the genus *Sympetrum*. The most abundant of these is the common darter (*Sympetrum striolatum*). It is a moderate-sized species with a wingspan of 5.5-6cm (over 2in). The wings are yellow right at the base, but otherwise clear, and the body is slender, red in the male but reddish-brown in the female. This is the dragonfly that you can often see in middle and late summer sitting on the handle of a spade or on a bare patch of earth in the sun. If you scare it away it soon comes back to the same spot. It remains on the wing later than any other species, sometimes even into late November.

It is common in southern England, but absent from most parts of Scotland, where its place is taken by the very similar Highland darter (*Sympetrum nigrescens*). Large pale

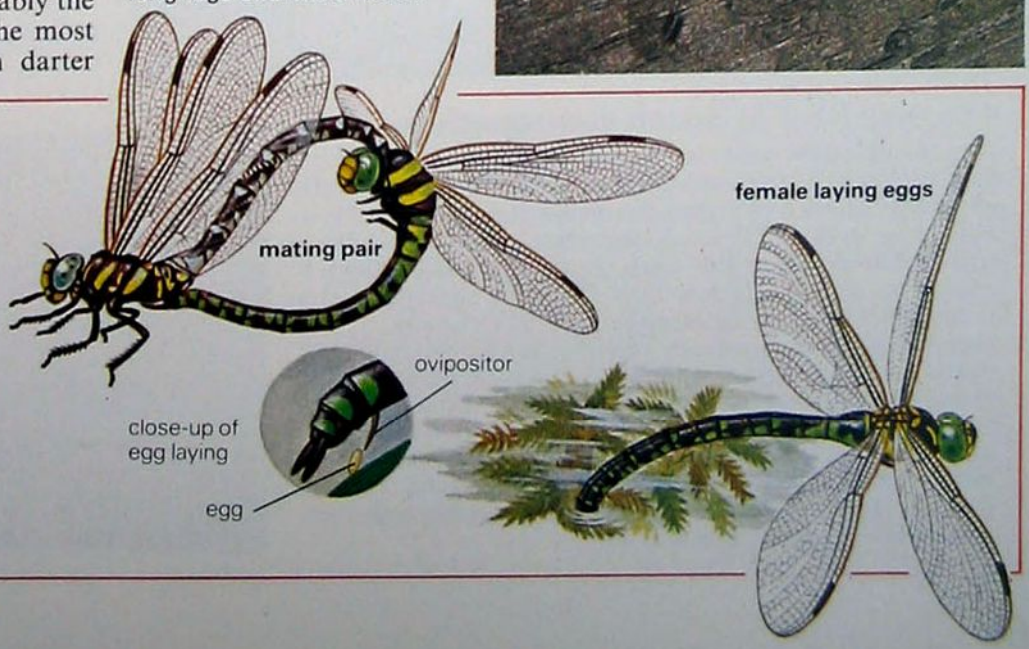
Below: Dragonfly larva of the species *Libellula depressa*. This larva is a mud-dweller and is commonest in southern England. Most adult *Libellula* males have a powder-blue hind-body, while that of the females is always brown. These dragonflies seldom go far from the marshes and pools where they breed. Their continued existence depends on the preservation of suitable breeding sites.

Right: Ruddy sympetrum dragonfly (*Sympetrum sanguineum*), one of the darters (so-called from their habit of darting out from a perch). Residents occur in south and east England; migrants coming from the Continent may be seen in other areas as well. *Sympetrum* dragonflies breed in clean ponds, canals, and ditches. The larvae are broad-bodied and short with long legs and wide heads.

Mating and laying eggs

Before mating the male common hawker (right) transfers his sperm from the end of his abdomen to an 'accessory' organ on his underside. He pursues a flying female, lands on her back and seizes her head with a pair of claspers at the tip of his tail. The female brings her abdomen up so that its tip touches the male organ, and sperm is transferred to her.

Egg-laying varies between species. Some insert the eggs in water-plant stems or in moss at the water's edge, others fly over the water and drop the eggs, while some dip the abdomen into the water to wash the eggs off the tip.



Below: Brown aeshna dragonfly *Aeshna grandis*. Both males and females of this hawker species have a dark brown body; they are common in south and south-east England. You can see this species from June to October, often in towns and well away from water. The female lays its eggs in ponds, lakes, rivers and canals and the larvae take anything from two to five years to reach adulthood.

specimens of the common darter seen near the south coast are likely to be migrants that have flown over from the Continent. Some of our other darter dragonflies are also regular migrants, including the black darter (*Sympetrum scoticum*). This species is common in marshy places on heather moors and is widespread in the British Isles in suitable localities (not confined to Scotland as its specific name suggests). The body is black in the male and dark brown in the female.

The other familiar and conspicuous group of dragonflies in the British Isles are the hawkers, of the genus *Aeshna*. These are much larger than the darters, with wingspans of up to 10cm (4in), and most of them are boldly marked with green, blue and black. You can generally see them in summer, flying up and down over a definite beat, often but not always over a stream, and they spend less time sitting at rest than darters do. In the southern and midland counties of England the southern hawker (*Aeshna cyanea*) is the species most often seen. It flies from July to September and both sexes have a black body spotted with green, the male with some blue spots near the end of the tail. It frequently breeds in garden ponds.

The common hawker (*Aeshna juncea*) is hardly less common, and much more widely distributed, its range extending from the south coast to Ireland and northern Scotland. It is commonest on heaths and moor lands. The male is dark brown with blue spots, while the female has green spots. The presence in both sexes of *A. cyanea* of a conspicuous yellow triangle in the centre line just where the abdomen joins the thorax, and its absence in *A. juncea*, is a good distinguishing mark if you can observe the insects closely enough to see their body colouring.

One of the largest and most striking of our hawkers is the emperor dragonfly (*Anax imperator*) which has a wingspan of nearly 10cm (4in) and has a bright blue and black abdomen. It is common in south-east England but does not occur in Scotland. This species is thought to be the largest hawker dragonfly in the British Isles.

Scotland has its special *Aeshna* dragonfly, the beautiful azure hawker (*Aeshna caerulea*) in which both sexes have a body spotted with bright blue. It is widespread in Scotland but by no means common.

Threat from pollution All wild life is threatened by pollution, but animals that live and breathe in fresh waters are especially endangered. There is little doubt that recent reductions in the numbers and ranges of our dragonflies are due to this hazard, and also to mechanical dredging of canals and ditches in low-lying areas. Unless action is taken to control these destructive agencies, our dragonflies, and much else that is interesting and beautiful, will disappear from the countryside of Britain.

The eyes have it—vision in dragonflies

Dragonfly eyesight needs to be good for the insects' mode of hunting. Their eyes are among the most highly-developed of all insects. Each eye occupies the whole of one side of the head. Their eyes, like those of most adult insects, are of the type known as compound—made up of minute units called ommatidia, each of which is rather like a tiny telescope. In each eye there may be as many as 20,000 of these, packed together in a precisely radiating bundle, the outer end of each appearing as a hexagonal facet on the surface of the eye. The radial arrangement covers a wide visual field—a dragonfly can spot a victim or enemy 12m (40ft) away in almost any direction. A result of their dependence on eyesight for hunting, finding mates and escaping enemies, is that the antennae—used in other insects for smell and touch—are degenerate and tiny.

WALLABIES IN A COLD CLIMATE

Above: The red-necked wallaby gets its name from the rust-coloured patch on its shoulders. The red varies in intensity, and is less conspicuous in the wild.

Red-necked wallabies were introduced to British zoos from Australia over 100 years ago. Since then a few animals have either escaped or been released. At least two small populations have survived in the wild for about 40 years–but today the future of these small kangaroos is far from secure.

The red-necked wallaby comes from Tasmania, an island off the south-eastern tip of Australia. Tasmania has a climate very similar to our own, which means that this particular species is accustomed to moderately cold temperatures. It has therefore done well in British zoos, and any visitor to Whipsnade will know that red-necked wallabies have the freedom of the grounds there and are very common.

Animals that have escaped or been released from captivity have established small colonies in the wild in at least two different parts of England. However, because wild wallabies are very vulnerable to disturbance by man, and their numbers are already precariously low, the location of these colonies has to be kept secret.

Excellent camouflage The front paws, hind feet and tail tip of the red-necked wallaby are black, the underside light grey, and the back a darker grey. This all provides remarkably good camouflage when the animal is still. There is no difference in colour between male and female, but the adult male is appreciably larger, and has a longer, blunter muzzle. The female has a more slender, tapered muzzle. The muzzle of the young male is similar to that of the female, and you can easily mistake a female for a young male until you notice the pouch.

Breeding The most interesting thing about

RED-NECKED WALLABY
(*Macropus rufogriseus*)
Length (head and body) Male 65cm (25½in), female 61cm (24in).
Weight Male 13kg (28lb), female 10kg (22lb).
Breeding season Generally August, but considerable variation.
Gestation period 30 days.
No of young 1.
Lifespan Max 19 years in the wild.
Food Shrubs, grasses, herbs.
Predators None. However, deaths caused by cars, and as a result of disturbance by man and dogs.
Distribution Must remain secret, to protect few remaining populations in Britain.

wallabies is their manner of breeding. Like so many Australian mammals, they are marsupials. (They carry their young in a pouch situated on the lower abdomen.) Young marsupials are born in an underdeveloped state–prematurely by the standards of other mammals–after a very short pregnancy. In the red-necked wallaby, pregnancy lasts only 30 days, but to compensate for this the period of suckling is relatively long–around 280 days.

Courtship consists mainly of the male chasing the female, trying to stroke her tail, generally keeping as close as possible, and threatening any other male that comes near. If he annoys the female too much, she may turn round and box him with her front paws. Rival males may also indulge in boxing.

When the young wallaby is due to be born, the female sits down with tail extended forward between the legs, and licks the pouch and groin to clean them. The young wallaby is only about 10mm ($\frac{1}{2}$in) long, and its hind legs, so enormous in the adult, are minute in relation to the rest of its body; its eyes and ears are closed. However, its front legs are well formed, with strong claws, and with these it crawls up through its mother's fur, into the pouch, with no help at all from her. It then attaches itself firmly to a nipple and remains attached for about two months. After that, it begins to move around in the pouch, and at about seven months old it starts to poke out its head to see what is going on outside.

In Britain, mating occurs mostly in August, so that the young are probably born in September (birth itself has not been observed in the wild). In April, the young can be seen sticking their noses tentatively out of the mother's pouch, and by the end of June they leave the pouch altogether.

There is some variation in this timetable, since courtship occurs as late as December, and pouch young have been seen in September. In the southern hemispheres, the timetable differs by six months, in order to match the seasons. Generally, the later part of pouch life and early freedom of the young wallaby coincide with the new growth of plant life in early summer whether this is June as in Britain or December as in Tasmania.

Free association Wallabies have no particular home site and, although they tend to move about in small groups, no social structure is apparent. Individuals move freely between groups. Juveniles stay away from these groups, perhaps because they are pushed out.

Wallabies have poor eyesight, but their sense of smell is good, and their hearing acute. The ears are extremely mobile, flicking back and forth like radar scanners to pick up the slightest sound. If greatly alarmed, wallabies hop off rapidly, downhill if possible, slapping the ground hard in the first few hops to warn other wallabies. Normally, however,

Above: The young wallaby does not poke its head out of its mother's pouch until it is about seven months old. Two months later, it leaves the pouch altogether.

Left: A white line along the upper lip and whitish spots over the eyes are characteristic of the red-necked wallaby. The face of this young animal will lighten as it gets older. If it lives to old age, most of its muzzle will be white.

they react to disturbance by crouching down, rather like hares, hoping to escape notice.

Feeding habits Wallabies generally spend the day in cover, hiding in scrub or on rough ground. At dusk, they become more active and feed intensively.

Wallabies are exclusively plant-eating (herbivorous), feeding on a wide variety of shrubs, grasses and other herbs. When available, heather is an important food source. In spring wallabies eat the new shoots of bilberry and in summer they eat a little bracken as well as grass. They also take the shoots of young pine trees, when they can reach them.

Wallabies have small mouths, and feed delicately, using their front (incisor) teeth to bite off the tastiest parts of the plants. When eating grass, they use their front limbs and tail alternately with their back limbs, to hitch themselves slowly forward in a 'five-legged' gait. They sit up to feed on heather or other shrubs, using their front paws to hold the selected shoots or pull them towards the mouth. Wallabies are not known to drink water, but they sometimes lick snow in winter.

Like ruminants, such as deer, sheep and cattle, wallabies have complicated stomachs with fermentation chambers. These chambers are full of micro-organisms that break down otherwise indigestible parts of food, particularly cellulose.

When they are not feeding, wallabies spend a lot of time grooming. They lick and nibble their forequarters, and lick their front paws before using them for face washing. The tail is pulled slowly through the front paws and licked. Like other kangaroos, wallabies have an extra grooming device, a 'comb' on the hind foot, consisting of the two smallest toes. This is used vigorously to scratch the ears and the back of the head.

Heavy casualties It remains to be seen how well the red-necked wallaby survives in Britain. One population of five animals, released in 1940, increased to about 50 animals by 1962, when the severe winter caused many deaths. Since then, this population has increased only very slowly. Over the last decade it has fluctuated between 10 and 25 animals. During this time, there have been at least five road casualties, and disturbance by people and dogs has caused some deaths. The combination of severe weather in 1979 with competition for food from sheep caused at least five deaths.

Given its apparent vulnerability to disturbance, severe winters and cars, it seems unlikely that the red-necked wallaby will ever become a pest here (as it has in New Zealand). We can only hope that tourists looking out for wallabies will keep their own disturbance to a minimum, and not chase the animals unnecessarily. Wallabies driven into less suitable habitats will no doubt fail to maintain their numbers and so die out. Also, if they stray on to surrounding farmland and eat vegetable crops, or get into timber plantations and nibble young shoots, they are likely to be killed by irate farmers and landowners. However, it is hoped that the red-necked wallaby, as our only wild marsupial, will continue to survive here.

Embryo-like young

Above: The hind legs of the newly born wallaby are hardly apparent. It uses its front legs to crawl up through the mother's fur into her pouch, where it attaches itself firmly to one nipple.

Below: When it is about eight months old, the young wallaby begins to make occasional sorties from the mother's pouch, in search of solid food. At around nine months, it leaves the pouch permanently, but it continues to suckle from the mother until it is at least a year old.

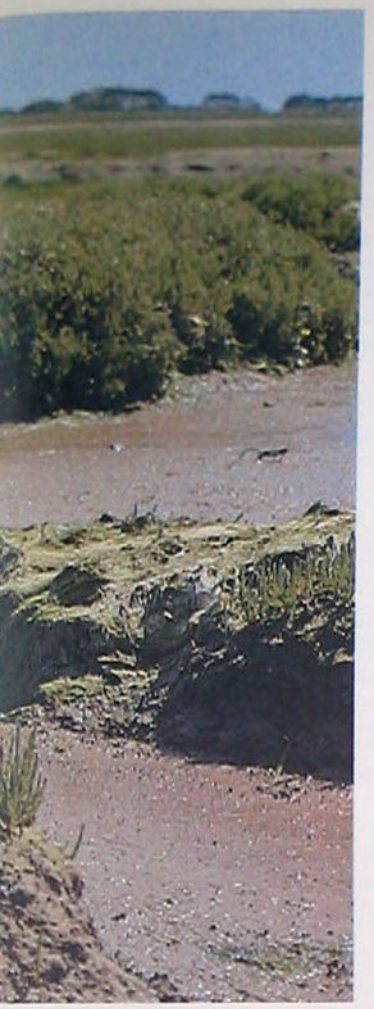
Left: The Latin name for the wallaby is *Macropus*, meaning 'big foot'. The long hind foot consists mainly of an enlarged fourth toe, but the fifth toe (our 'little' toe) is also quite large. The first toe (our 'big' toe) is missing, and the second and third toes are very small, closely joined together on the inside of the foot. The wallaby uses its smallest toes as a comb for grooming its ears and the back of its head.

FLOWERS OF SALT & SILT

Midway between firm land and pounding sea, the salt marshes of Britain's coastline boast a variety of attractive flowering plants which are well adapted to life in this highly exposed habitat.

The coasts of the British Isles boast a variety of habitats – cliffs, sand dunes, shingle beaches and salt marshes. Each habitat has a unique flora although some of the constituent species can live in several habitats. Salt marshes, which have a sandy or muddy base, are regularly inundated by the tidal flow of the sea so salt marsh species growing there have to be able to conserve moisture and endure salt. In late summer and early autumn you can find a rich patchwork of different flowering and fruiting species, although often there is one dominant species, such as glasswort.

Glasswort is one of the most common pioneer species of salt marshes. Provided the seeds land where they can get enough ex-



Above and left: **Glasswort** (*Salicornia*), also called marsh samphire, flowers from August to September and grows to a height of 30cm (12in) in salt marshes. There are six annual and perennial species growing in the British Isles and they are difficult to tell apart.

posure to the air, usually near the high tide mark, they will germinate, eventually forming colonies that catch silt and mud in their leaves and stems. In time the level of the surrounding beach is raised and so a salt marsh begins to form. In order to survive in these conditions the glasswort's leaves have become reduced to fleshy scales. The whole plant is dark green at first, turning yellowish-green and finally pink or red, and it can be eaten (like rock samphire).

The sea aster is a familiar perennial of all levels of salt marshes where the saltiness is not too excessive. It is a colourful species with fleshy leaves. The flowers are typical of the daisy family and look much like those of the garden Michaelmas daisy with their bluish-purple ray florets and yellow central disc florets. A rayless variety (var. *discoideus*), found mainly in the East Anglian marshes, has only yellow florets which turn a muddy orange colour after pollination and finally fade to brown.

Sea wormwood, or **southernwood**, is an aromatic perennial species with upright or semi-prostrate stems. The stems and undersides of the divided leaves are covered in woolly hairs so that the whole plant has a silvery appearance. The individual felted and drooping flowers, each on a short spike, are yellow or reddish-brown.

Annual seablite flourishes best where there is plenty of sand mixed with mud and is usually found where other vegetation is well established. It varies greatly in size and manner of growth, its smooth, slender stems being either erect, or prostrate and straggly. The blue-green leaves are narrow, and the insignificant flowers are borne in the leaf axils. The flowers eventually develop into shining black seeds which are dispersed by the sea. In autumn the whole plant becomes an attractive red colour.

Sea sandwort is short and anchored by creeping rootstocks. It is an aggressive pioneer species and as it becomes covered by wind-blown sand it soon sends up new shoots and forms neat mats. It survives exposure to salt spray well. The inconspicuous greenish-white flowers open only in the bright sunlight. In Yorkshire at one time the whole plant was pickled and used as a salad delicacy; it has a sharp biting taste.

The sea or **yellow horned poppy** can light up the shingle with a bright splash of colour when it grows in large patches. It is a biennial with a first-year rosette that sits on the

Above right and right: **Sea aster** (*Aster tripolium*) flowers from July to October in salt marshes, on cliffs and rocks. The blue-purple variety is common around the coasts of England and Wales and in Scottish estuaries. The rayless orange-yellow variety (var. *discoideus*) is mainly confined to the marshes of East Anglia.

Yellow horned poppy (*Glaucium flavum*) flowers June-Sept on shingle, cliff tops, sand dunes around the British Isles; rare in Scotland. Has the longest pod of any British wild flower—up to 30cm (12in). Ht 50cm (20in).

ground and is the only overwintering stage. The shoots come up in the second year and flower from June to September. In its flowering season it has a tall stout stem; the flowers, which last no more than two days, are an attractive shade of yellow and similar in shape to those of the red poppy. By winter only a rosette of bluish-green hairy basal leaves is visible.

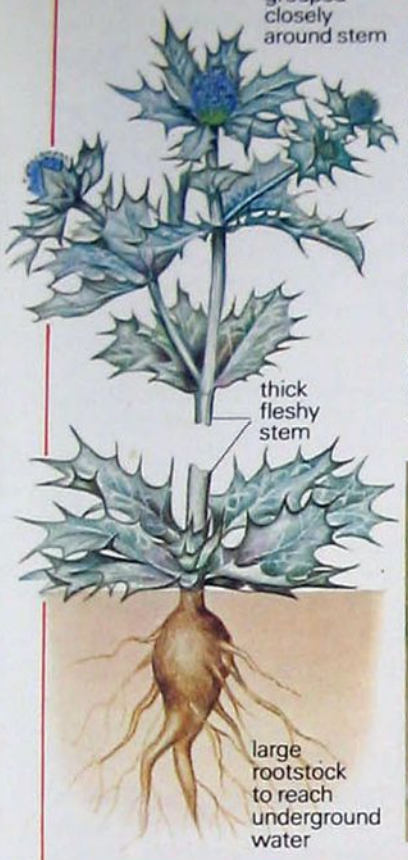
A striking feature of this poppy is its seed pod which is quite different from the 'pepper shakers' of many other poppies. It is the longest capsule of any British wild flower; its sticky, unpleasant-tasting, yellowish-orange sap used to be applied to bruises—hence one of the poppy's old names, bruisewort.

Sea purslane grows on the banks of tidal creeks of salt marshes in well aerated soils. Its leaves have a silvery-white sheen on both sides from a mealy coating of fine white scales. Viewed from above, it looks like a grey ribbon winding across the marshes. You usually see the wiry stems of this low shrubby perennial lying on the ground. They root easily, sending up erect branches with reddish-

Sea purslane (*Halimione portulacoides*) flowers July-Oct in saltmarshes that are flooded at high tide. Ht 45cm (18in).

Prickly saltwort (*Salsola kali*) flowers July-Sept on sandy shores all round the British Isles. Ht 40cm (16in).

Water-conserving plants



A Xerophyte is a plant which spends its life in a habitat where water is difficult to obtain. The most obvious example is a cactus in the desert. Sand dunes are the nearest thing to deserts in this country. Xerophytic plants have one, or several, modified structures to reduce water loss: leaves reduced to little more than scales, or leaves rolled up; branches and leaves reduced to thorns; thick-walled cells resistant to dehydration; thick cuticle; sunken stomata; thick waxy bloom; great hairiness. Many xerophyte plants have extensive roots, rhizomes or tap roots and the stems are often fleshy. A particular coastal xerophyte in Britain is sea holly (*Eryngium maritimus*) which flowers from July to August and grows to 50cm (20in).

grey bark. In good conditions it can spread easily to form a thick mass and excludes any other species competing for light and space. The numerous yellowish-green flowers are tiny: the male has a five-lobed calyx and no petals, whereas the female has two flat triangular segments, which develop round the fruit.

Prickly saltwort This species is usually prostrate, with soft fleshy branching stems. The hairy leaves have spines at the tips to help conserve moisture in dry situations but can endure some immersion in salt water. Like glasswort, prickly saltwort is a source of soda, obtained by burning great quantities of plants. The ashes (barilla) were once used in the manufacture of soap and glass.

Sea holly is a far more attractive perennial than the marram grass and sedge usually associated with it. Although it is a member of the carrot family, it has little outward similarity to its relatives. The basal leaves are spine-toothed, bluish-green and somewhat rounded or heart-shaped; the upper leaves are more oval, leathery and hug the stem. The beautiful blue sweetly-scented flower heads emerge from the leaf axils and are somewhat hidden by the leaves. Each individual flower is protected by a three-forked spiny bract.

Autumn squill is a rare and delicate species that you sometimes find among the grass on cliff edges. It develops from a bulb of about 2.5cm (1in) wide. When it is in flower in late summer and early autumn, its leaves are no more than a tuft at the base of the flower stem, but they continue to grow after flowering has finished, and are only fully developed by late autumn. The small erect flowers with their purple anthers are pale violet blue. This species is much less common than the spring squill and only grows in any quantity in Devon and Cornwall.

Left: **Sea wormwood** (*Artemisia maritima*) flowers Aug-Sept on shingle, sea walls, cliffs, and drier salt marshes. Ht 40cm (16in).

Below: **Annual seablite** (*Suaeda maritima*) flowers June-Oct in salt marshes, on the seashore, the heads of Scottish lochs. Ht 40cm (16in).

Below: **Sea sandwort** (*Honkeyna peploides*) flowers May-Sept on coastal dunes and shingle, river estuaries. Ht 20cm (8in).

Below: **Autumn squill** (*Scilla autumnalis*) flowers Aug-Sept on cliff tops and short grassland in the south-west of England, Wales. Ht 15cm (6in).

AROMATIC JUNIPER

Juniper – our only native member of the Cypress family – has the greatest world range of any conifer. In the British Isles it grows only in Scotland and southern England, usually as a low-growing shrub.

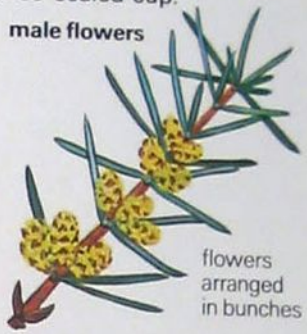
Juniper (*Juniperus communis*). Native, evergreen, usually low-growing but may reach 10m (33ft). Grows on chalk downs, heaths, moors, limestone, mainly in S England and Scotland. Fruits Oct.

Juniper grows throughout the northern hemisphere in a broad belt which sweeps across North America, Europe and northern Asia. In the British Isles, it has a particularly interesting distribution. In Scotland it is found in native Scots pine forests, birchwoods and on heather moorland. On high mountains it sometimes forms low-growing scrub just above the tree line.

In southern England it grows in the chalk down grassland, especially on steeper hillsides where the soil is shallow. In the rest of the British Isles it is absent except for a few scattered localities in Ireland, north Wales and northern England. For reasons that are not fully understood the juniper is declining in southern England; in many sites only old plants remain and there are no young bushes. Although the old specimens produce plenty of berries, their seeds are either failing to germinate or the seedlings do not get properly established in the turf.

The two main strongholds of juniper are not only widely separated, but based on completely different soil types. Junipers in Scotland thrive on acidic soils, whereas in southern England the soils overlaying the chalk are alkaline. However on chalk junipers seem to grow best on steep slopes where the soil is thin and poor in nutrients, a characteristic in common with the shallow soils weathered from hard rocks further north.

Female flowering cones, 3mm ($\frac{1}{8}$) across, consist of a three-scaled cup.



Male flowering cones are 6mm ($\frac{1}{4}$in) across and bear the pollen sacs.

The juniper is a rather rigid bush, its branches densely packed with narrow needle-like leaves arranged in whorls of three. Each leaf is about 2cm ($\frac{3}{4}$in) long; the upper surface has a waxy sheen and is blue-green in colour, whereas the underside is a much darker grey-green. The leaves taper to a stiff point which makes the foliage prickly to touch.

In some ways the juniper resembles the yew and they frequently grow together on steep-sided ridges and combes on southern downland. Indeed, in north Wales the juniper is known as the dwarf yew.

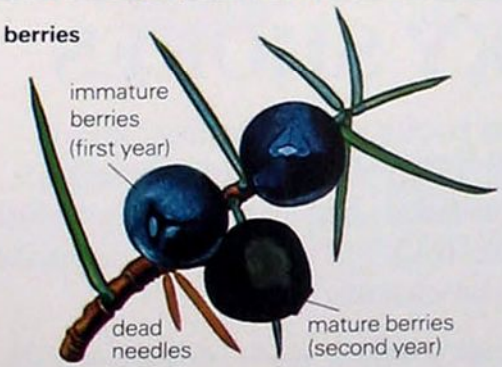
Shaped by wind and weather The shape of juniper bushes varies considerably with age and area. On young plants numerous short, rigid side branches grow upwards from the central stem to form a tight spire-shaped crown. In sheltered sites this may eventually result in a substantial bush up to 10m (33ft) high.

Where the bushes are subjected to strong winds or heavy snow they rarely exceed 3m (10ft) in height. In such exposed sites their growth tends to become rather lop-sided, shaped by the wind; sometimes the weight of snow snaps off branches, resulting in a more open, ragged bush. On bleak windswept moors and mountain sides junipers become flat-topped, creeping shrubs, rarely exceeding 20cm (8in) in height.

Small hard cones The juniper 'flowers' in May or June and is wind-pollinated. The 'flowers' are in fact cones; male and female cones are borne on separate plants towards the tips of the twigs. The yellowish male cones bear the pollen sacs. The female cones consist of a cup of three to eight scales. After pollination they expand, fuse and grow around the developing seed.

In autumn the female cone swells to form a hard green berry which encloses two to three seeds. They remain on the bush for two to three years, gradually ripening to fleshy berries. These are blue-black in colour and the outer skin is coated with a greyish bloom. The ripe berries are eaten by birds, such as thrushes, which disperse the indigestible seeds in their droppings. In Scotland grouse are thought to be largely responsible for the spread of juniper.

The stems of older bushes are covered with stringy, reddish-brown bark which peels off in strips. Junipers grow slowly, especially in the face of strong winds, and the width of the stem bears no relation to the age of the bush, as one research worker at The Monks Wood Experimental Station has discovered. A large juniper from a sheltered site had a stem width of about 26cm (10in); after its growth rings were counted, it proved to be 84 years old. Another specimen growing on a windswept site had a stem width of only 6.5cm ($2\frac{1}{2}$in), yet it proved to be 186 years old. In Russia a 544 year old tree had a stem of 8.3cm ($3\frac{1}{4}$in). However, no juniper over 200 years old has been found in Britain.



Above and left: Juniper berries (actually berry-like cones) have aromatic flesh. The juice is used to flavour gin. Those who assert that they drink gin 'purely for medicinal purposes' may be reassured to know that their claim does have some basis in truth: oil of juniper, which can be bought from chemists, is a powerful remedy for flatulence.

Considering the stature of juniper it is perhaps surprising that it yields a useful timber. The wood is exceedingly tough and used to be much in demand for making decorative veneers. After a good polish the wood gleams a rich red colour. In the Lake District the wood was burned to charcoal which was used for gunpowder. Juniper sticks were also burnt on home fires to scent rooms with its aromatic smoke. Elsewhere in Europe this was done to keep evil spirits at bay and protect the house from sorcery.

In the past the berries were swallowed by pregnant women to induce abortion – hence one of their local names, bastard killers'.

Far left: Tynron Juniper Wood Nature Reserve in Dumfriesshire. The character of juniper has been well described by the poet Laurence Binyon:

The slope is darkly sprinkled
With ancient junipers,
Each a small secret tree:
There not a branch stirs.

LIMPETS: SNAILS OF ROCKY SHORES

Limpets attached to rocks are a familiar sight around our coastline. Their shells are exposed to the relentless pull of the tides, but the animals inside clamp themselves to the rock surface, safely secured against the stormy seas.

The common limpet (*Patella vulgata*) may reach 7cm (3in) in length, and is one of our largest and best known limpets. It lives on rocky shores—except the most exposed and the most sheltered—and is found in a belt along the middle shore. The common limpet also attaches itself to piers and pilings at the same tidal level. The scars, or ring marks, where the animal's shell has worn against the rock surface, are clearly evident here.

Limpets are algae-eating sea-snails and belong to a major group of invertebrates, the molluscs. The strongly constructed, cone-shaped shell fits over the whole animal, protecting its soft body from seabird attacks, and alleviating the pressure of pounding waves as they break over the rocks.

Life on the exposed shoreline is hazardous for limpets, particularly because of the tidal cycle which makes shore dwellers vulnerable to sharply contrasting conditions. When the tide is in, limpets are immersed in seawater at fairly constant temperatures; when the tide is out they are exposed to desiccation and rapid temperature changes, as well as the occasional shower of rain. To combat this, limpets can clamp their shells hard against the rocks, sealing themselves off from the hostile elements. This also restricts water loss and invasion by freshwater until the tide returns.

Inside the shell The body of a limpet is made up of three basic parts (see illustration): the abdominal (visceral) mass, which houses the digestive, reproductive and excretory organs and which is covered by a special area of skin called the mantle; the moderately developed head bearing the mouth and sensory organs; and the foot, which is situated below the abdominal mass.

Each limpet has a flat, well-developed, sucker-like foot which plays two important roles. First it is a powerful attachment organ. Many limpets live on exposed shores where, in stormy weather, heavy seas exert immense force. The limpet uses its foot to anchor itself to smooth rocks. The muscles of the body can pull the shell down hard against the rock and effectively seal the animal inside. The limpet may clamp down so tightly that the rocks are often marked in rings where the shell regularly presses against them. The foot also enables the limpet to crawl forward, with alternating phases of contraction and relaxation. These pass across the foot like minute ripples, thrusting it against the rocks and giving it forward locomotion.

Rasping trails The tentacles on the head, and the other sense organs of the body, pass information to the simple brain about the

presence of food. The limpet then gathers up food by using a special feeding organ known as the radula. As in many molluscs, including snails, this takes the form of a rasping tongue-like organ. Under the microscope it looks like a ribbon that carries hook-like teeth.

The radula, situated inside the mouth, is constantly being renewed at one end, while being worn away by everyday use at the other. As the limpet feeds – on weeds and the fine film of microscopic algae and detritus which cover the rocks – it presses the radula against the rock and pulls it back and forth so that pieces of algae are filed off together with particles of the rock itself. This rasping activity leaves the characteristic marks on the rock known as limpet trails.

Adult limpets remain in one place on the shore. They normally feed when they are covered by the sea at high tide, though they sometimes forage on moist days when the tide is out. After each feeding expedition, they return to the same 'home' spot. By their regular grazing activities, limpets keep the rock where they live clear of developing algae and small encrusting animals. In this way they are an important factor in controlling the development and abundance of some other shore species.

From egg to larvae There are male and female limpets. They usually reproduce in early spring, though this depends on the species. When the female releases her eggs into the sea, the male releases his sperm, and fertilisation takes place. Microscopic, drifting larvae hatch and soon develop as members of the planktonic community. At first, the larvae feed on stored food material from their egg, but after a while they take microscopic algae drifting in the sea. After several months they are ready to settle on the shore-line and change into juveniles. They are particularly vulnerable to predators, such as rock pool fish, at this time.

Examining a limpet Telling the common limpet (*Patella vulgata*) from its relatives *P. aspera* and *P. depressa* is difficult; you have to knock the limpet off the rock to examine the underside of the animal with a lens.

Around the tip of the mantle, just inside the shell, runs a ring of delicate tentacles. If these are transparent, and invisible except through a lens, then it is the common limpet. If the tentacles are opaque, and visible to the naked eye, then it is one of the other two. In *P. aspera* the foot is orange and the shell interior is orange-grey, with brownish markings running only a short way inside. In *P. depressa* the foot is cream to brown, but the brown markings inside the shell extend a long way in from the lip. It is also the harder of these two to find, as it occurs only on exposed middle shore rocks, while its relative is generally restricted to lower shore rocks. The common limpet is more widespread around the middle shore zone.

Five common limpets

Below right: **Blue rayed limpet** (*Patina pellucida*), 1.5cm ($\frac{3}{4}$in) long. Lives and feeds on *Laminaria* kelp. It is easily recognisable by its brownish shell and brilliant bluish rays radiating from the apex. Younger specimens (below left) are more boldy marked and live on the fronds, while the older ones attach to the holdfasts.

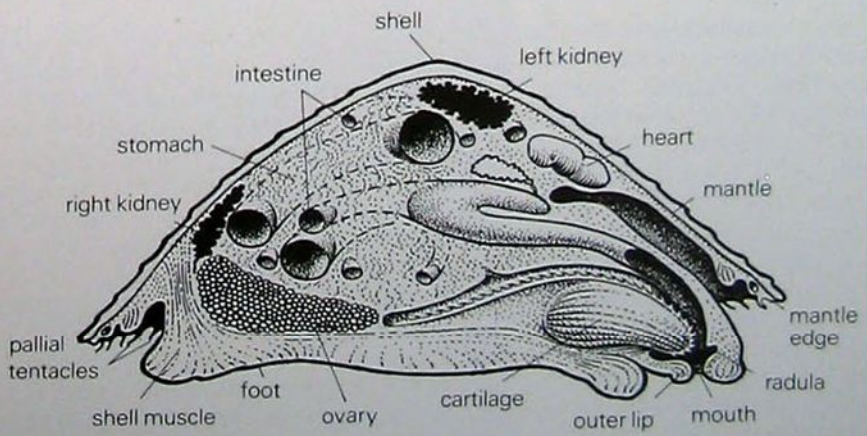
Above: **Key-hole limpet** (*Diadora apertura*), 4cm ($1\frac{3}{4}$in) long. Unmistakeable hole in apex of shell Lives on lower shore rocks down to 20m (65ft).

Right: **Slit limpet** (*Emarginula reticulata*), 2cm (1in) long. Narrow slit at front lip of shell goes in nearly 5mm ($\frac{1}{4}$in). Found on rocks on lower shore, feeding on algae down to 60m (200ft).

Left: **Tortoiseshell limpet** (*Acmaea tessulata*), 2.5cm ($1\frac{1}{4}$in) long. Brownish tortoiseshell-patterned shell. Distribution as for *A. virginia*.

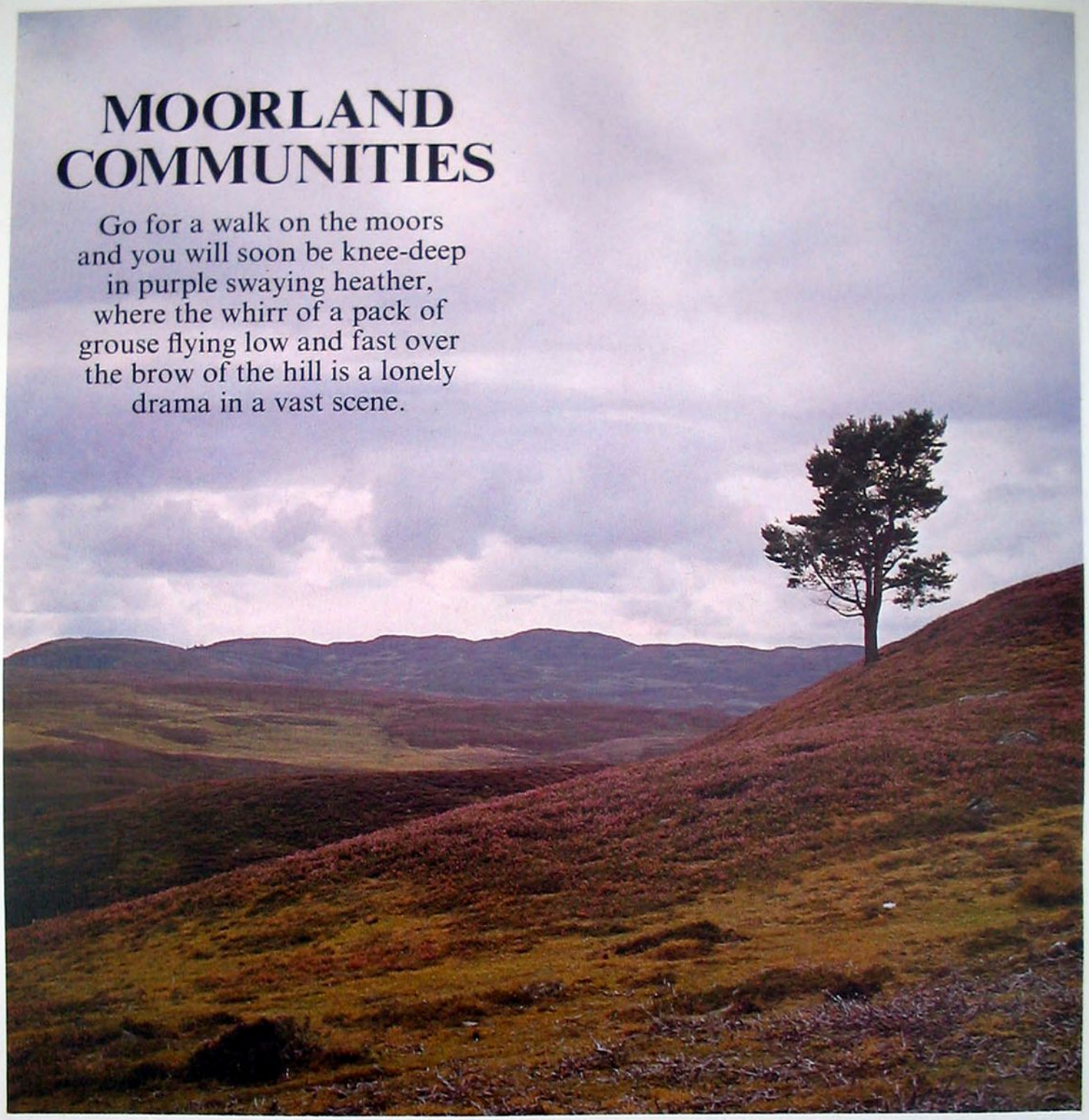
Right: **White tortoiseshell limpet** (*Acmaea virginia*), 12mm ($\frac{1}{2}$in) long. Pale shell. On lower shore and in shallow water down to 10m (32ft) sometimes on algae.

Cross-section view inside a limpet



MOORLAND COMMUNITIES

Go for a walk on the moors and you will soon be knee-deep in purple swaying heather, where the whirr of a pack of grouse flying low and fast over the brow of the hill is a lonely drama in a vast scene.



Widely distributed in northern Britain, the main heather moorland areas are found in the Peak District, North York Moors, Northumberland and the Southern Uplands and Eastern Highlands of Scotland. Other areas in the country may still retain remnants of a heather moorland vegetation but are now largely dominated by hill grasses. These are the home of grazing animals such as sheep and possibly deer, rather than grouse which is always associated with heather moorland.

All these moorlands have been formed since the last great Ice Age came to an end about 10,000 BC; the chief factor in their formation was a wet climatic period about 5000 to 6000 BC during which sphagnum mosses flourished, covering large expanses of upland Britain in blanket bogs. One of the peculiar characteristics of sphagnum is that it possesses a chemical that kills bacteria, so that when the moss dies it does not decay; over many hundreds of years layers of sphagnum have built up, and these became peat.

Peat underlies most of our moorlands, sometimes to a depth of several feet. The vegetation which grew on the peat in ancient times was scrub willow, birch and pine, with cotton sedge in the wetter areas and heathers and grasses in the drier parts. When man started to settle in the upland areas, perhaps five thousand years ago, trees were cleared to provide grazing; at a later stage the moors

In fine weather, moors are places of unending peace and solitude. Above is a typical heather moor in Perthshire, with a pine tree acting as a landmark that can be seen for miles around. Devon's Dartmoor (right) has miles of grass-covered scenery, dotted with scrub. In the distance is Wistman's Wood.

came to be managed for grouse and this caused vast areas to be covered with heather.

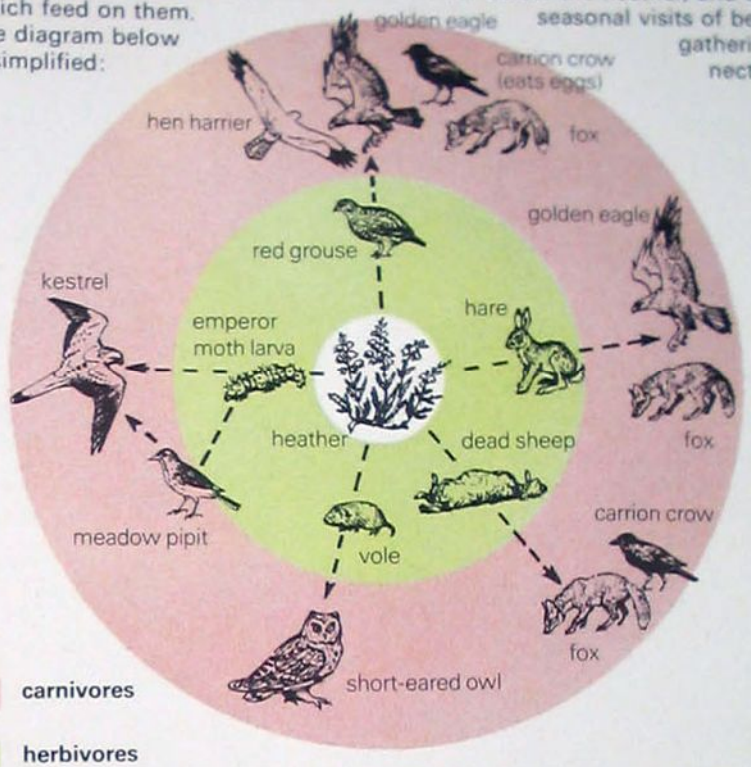
The red grouse (see page 473) is the subject of attentive care by gamekeepers and in many areas numbers are now higher than a century ago. The red grouse have four main requirements: old heather for cover, young heather (which is the staple diet), grit to swallow and water to drink. Grit and water are available naturally, but the mixture of young and old heather is enhanced by burning. When a patch has been burnt down, young shoots spring up which provide more nutritious food for the grouse and its chicks.

Eliminating the competition The maintenance of heather moorlands for grouse shooting (and in some cases for sheep grazing) has not been achieved without cost to other animals and plants. The main work of gamekeepers has been to persecute, by gun and trap, the other wildlife which either compete with the grouse for food or may kill the grouse themselves. Foxes, stoats and weasels are the grouse's main mammal enemies, and amongst birds both the predators and the ravens and crows have been killed to save the grouse.

Wander over a heather moor today and you may nevertheless be lucky enough to see birds of prey. Kestrels and the tiny merlin perhaps, but you have less chance of seeing peregrine falcon, buzzard or hen harrier. The golden eagle, which bred as far south as the Peak District until the mid 17th century, is now

Heather's central role

Heather plays a central role in the life of a moorland community, first as a food plant for herbivores, and then for the predators which feed on them. The diagram below is simplified: for example, kestrels will also eat voles; and not shown are the small insects in the leaf and twig litter below the heather, and the seasonal visits of bees gathering nectar.



Below: Moors are a feature of the upland areas. Scotland has the largest moorland area, followed by Ireland, Northern England and Wales.

confined mainly to the Scottish highlands.

During the summer the moors are visited by several birds that breed there. Notable among these are the golden plover, with its mournful 'peeping' call and the dunlin, a rather less timid bird. Both tend to prefer slightly wetter areas for nesting. The curlew, like the plover and dunlin, winters by the coast and migrates up to the moors in spring to breed, preferring tall heather in which to nest. Its gliding flight and bubbling call are a feature of the moors in spring. Three song-birds are particularly associated with the moors in summer: skylark, twite and, in greater numbers, the meadow pipit, with its twittering song and parachuting downward flight.

Insects of the moors Apart from the grouse, all these birds feed mainly on the numerous insects which the heather supports. Each species of insect specialises in its way of deriving a living from the heather: feeding from the sap of the plant are frog hoppers (whose larvae make cuckoo spit), and leaf hoppers. Eating the leafy shoots are the larvae of several moths, notably the fox moth, northern eggar and, most spectacular of all, the emperor moth.

Another insect closely associated with heather is the heather beetle. This can occasionally reach plague proportions and seriously damage the heather, sometimes with an effect on grouse numbers locally.

The litter which accumulates beneath the heather is food for springtails, whilst predatory spiders, harvestmen and beetle larvae feed on the plant-eating species.

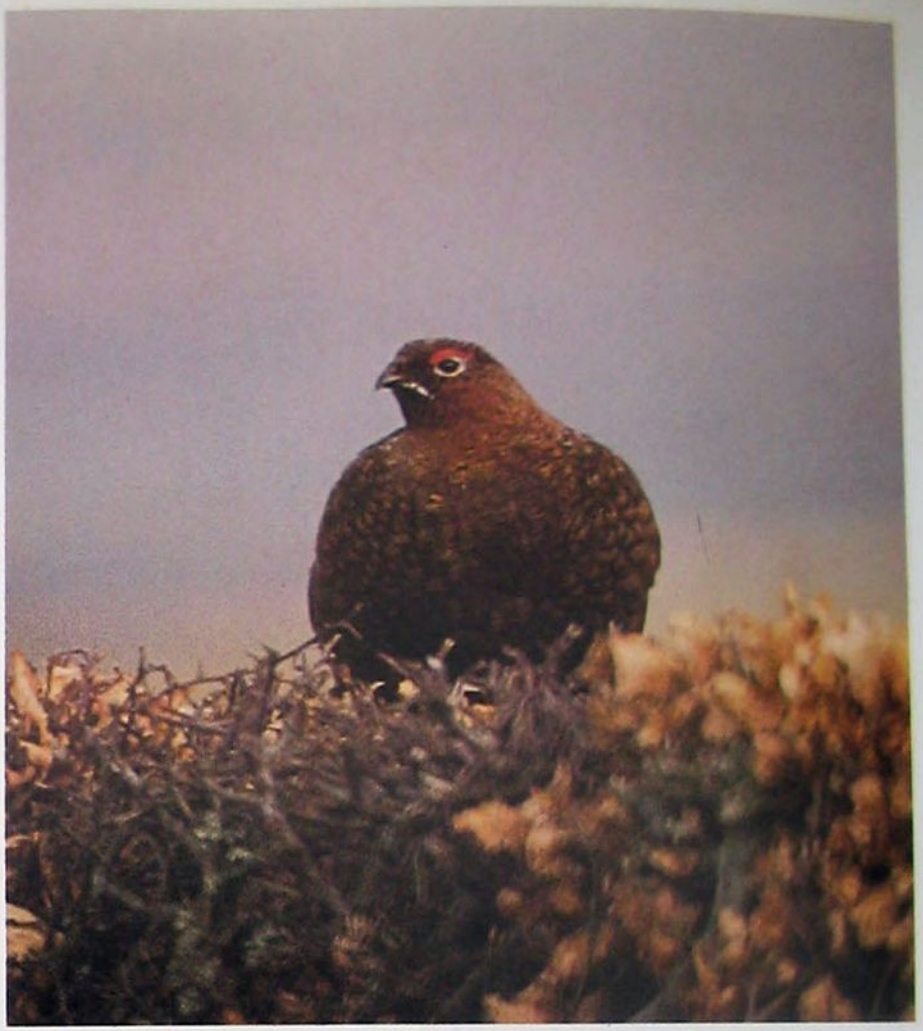
Cotton grass and bilberry On wetter moorland, cotton grass is often the commonest plant. Cotton grass supports fewer insects than does heather, although in the wet peat on which it grows several insect larvae may be found – particularly cranefly larvae, which play an important part in the moorland food-chain, especially as food for the breeding dunlin and golden plover. Also growing in wet peaty areas, the attractive pink-flowered cross-leaved heath adds a dash of colour.

In dry areas, the redder and larger-flowered bell heather is often found alongside the common heather or ling. The flowering of bell heather begins earlier and lasts much longer than that of the common heather. Other dry places may contain bilberry and its close relative, the red-berried cowberry.

Where sheep graze heavily on a moor that is not regularly burnt, grass often tends to take over from the heathers. Sometimes the grass is succeeded by bracken, which can spread quickly and exclude other plants by its dense shade.

Social change and the moors The countryside is always changing and the moorlands are no exception. Changes in the activity of man can greatly alter the natural environment. An increasing demand for wood creates new plantations of conifers; demand for water, too, continues to rise and bring new reservoirs into being. Another growing requirement of modern society is open areas for leisure activities, and so more walkers and holidaymakers appear than before – increasing the risk of fires in dry seasons. It may be, too, that smoke and gases from industry harm the moorland communities.

It is not surprising, then, that the total area of our moorlands has suffered a measurable reduction in the past forty years. It is hard to imagine that the conifer plantations and uniform grasslands which are replacing them will be as rich in natural interest or as full of that peculiarly lonely, weatherbeaten charm of Britain's upland heather moors.



Above: The red grouse of British moorlands is a native sub-species that is not found in other countries.

Left: Bilberry, which in dry moors can grow in extensive patches, is essentially a woodland rather than a moorland plant. This provides a clue to the history of the moors – long ago they used to be woodlands and scrub. Several of the moths and beetles of the moors are considered as moorland forms of woodland species.

SOLITARY EARTH WORKERS

The mole is the only British mammal that spends most of its life underground. It is also our most efficient digger. Using powerful forepaws, it excavates a set of tunnels for its home and waits for food to drop in.

Below: The sudden appearance of mounds of loose earth is a sure indication of the presence of at least one mole, which can be active over a large area. You will have to be patient and very quiet, however, to see a mole surfacing.

The mole can shift soil extremely rapidly. Placed on the surface of a lawn, it will disappear into the soil in as little as 15 seconds if the ground is soft, and only about a minute in compacted clay soil. When excavating its burrow, the mole may move more than 6kg (13lb) of soil in 20 minutes. Comparing the weight of a mole–100g ($3\frac{1}{2}$oz) –and that of the average human male–70kg (154lb)–this is equivalent to a man moving more than 4 tonnes of earth!

Perfect for burrowing The mole's anatomy is ideally adapted to its way of life. The cylindrical body fits neatly into a burrow, and there are no ear flaps or other appendages to get in the way.

The most obvious adaptation for digging is in the forelimbs. The spade-like forefeet have five long, strong, pointed claws which can dig through the hardest soil. The bones and muscles of the forelimbs and the shoulder joint are also well adapted for efficient burrowing. There is an extra bony support within the forelimbs to strengthen them, and the shoulder joint is situated far forward on the body, almost under the lower jaw, to allow the mole to dig in front of its nose. The muscles are exceptionally powerful and much more developed than in the related shrews, which do not dig in the soil. The hind limbs and feet are not modified to such an extent, since they play little part in digging.

Digging techniques Moles have two different

methods of digging. In soft soil, they use a 'breast-stroke' technique and almost 'swim' into the earth. This method is also used in sandy soil, where tunnels can only be temporary.

When making a deeper, permanent burrow, a quite different method is used. Here the animal uses one forefoot at a time. As already mentioned, the hind feet are used to brace the body against the sides of the tunnel, and one forefoot is also pressed firmly into the earth. The other forefoot then digs into the soil. When hard at work, the mole makes several scrapes with one foot, and then turns over and uses its other forefoot. A mole can dig for several minutes before it needs to stop and rest.

Underground isolation Adult moles each have their own tunnel system, in which they live solitary lives. The burrow may be 200m (220yd) long, snaking about in an area of perhaps 600 sq m (670 sq yd). It includes one or more nests, lined with grass or leaves which have been collected above ground and pulled down into the burrow. In firm clay soil rich in fauna–particularly worms–moles may do little digging, as they find plenty of food dropping into the tunnel. In poor soils, they may have to enlarge their underground territory constantly to seek more food.

Life above ground Baby moles, which are born in early spring, are suckled by their mother for about a month. But in May or June, when they are only half-grown, she drives them off to fend for themselves. They live among the grass for some time and may travel quite long distances–up to half a mile. During this period they are often killed and eaten by kestrels, tawny owls and other predators. Some are also run over by traffic. Eventually those that survive make new burrows and resume an underground life; some lucky individuals find untenanted tunnels made by previous generations.

Above: In dry weather, when earthworms are scarce, moles will surface in search of other food. This mole is eating carrion.

Below: You will notice how clean the fur is on this surfacing mole. This is because the coat is waterproof and will not get caked with earth, even in the dampest soil.

Although adult moles are predominantly subterranean, they come to the surface more often than might be supposed. On warm moist nights, when earthworms can be found on the surface of lawns, moles come out to catch them. And in very dry weather, when few worms enter the burrows, food–particularly insects–is sought above ground.

Brief encounters The short period when the mother and young live together is the nearest moles get to any form of social life. The sexes do meet and pair, in late February or March, but they only remain together for a few hours. At all other times when two moles meet, they attack each other ferociously. Sometimes they even fight to the death, although more usually the weaker animal retreats before it is seriously injured. Except in the breeding season, both sexes are equally aggressive.

Sharing your garden Mole hills are the basic reason why this species is considered a pest. A keen gardener is naturally incensed when a series of heaps of loose earth appears and disfigures the velvet turf. This may happen in just a few days and give the impression that an army of moles has entered the garden; but almost certainly only one animal is to blame. In a field, particularly adjacent to an area of old woodland, larger populations may be involved, but seldom more than three moles to an acre.

In a garden, it may be possible to have a good lawn and a resident mole. When the tunnel system is complete, the hills can be brushed away, and few more will appear if

the underground territory is sufficient to support the burrower.

During very cold weather, when the upper layers of the soil are frozen hard, crops of mole hills often appear. This gives the impression that digging is possible in frozen soil. In fact, what has happened is that the cold has immobilised the worms and insects in the surface layers of soil, and the mole has had to dig deeper into the warm earth to find food. The vertical shafts have remained open, and the soil is pushed up them. So even in a lawn where in warm weather digging is no longer practised, some damage may take place in winter.

Mole control Until about 70 years ago, many countrymen made their own traps, with a springy willow rod actuating a wire snare placed in the burrow. There were also several commercially made traps, the most popular being the scissor trap. Up to about 1914 mole skins were used to make ladies' coats, and waistcoats for country gentlemen. A farm worker could make more money trapping moles in his spare time than he earned from his employment. Today there is no market for mole skins, and trapping is seldom practised.

The most usual modern method of control is by poisoning with strychnine. This deadly poison may only be bought with a permit, but its use is often abused and foxes, for example, may be deliberately poisoned. The correct use of strychnine is to roll earthworms in a mixture of the chemical and talcum or other powder. The worms are then dropped into the mole's burrow, and the hole made for the introduction filled in with earth. This method is very effective and if it is applied with care, there is little risk to other wildlife.

However, strychnine is a cruel poison, and many would hesitate to use it if they saw the moles dying in agony. Attempts are being made to find more humane methods of control, but so far without success.

For information about the senses and general behaviour of the mole, see page 110.

Above: A common complaint from farmers is that mole hills cover up good grass and reduce the amount of grazing. Mole hills also damage the knives of grass-cutting machinery. With the invasion of arable land, moles may uproot rows of crops and damage the roots of others. But they are seldom a major pest and some farmers will put up with their presence. Others are not so tolerant and kill the offenders.

How a mole hill is made

When a mole has dug some distance underground and its burrow is becoming blocked by the loose soil that has been excavated, it digs a vertical shaft to the surface. The mole then pushes the spoil up and out of this shaft. A hard-working mole can push out 6kg (10lb) of soil in about 20 minutes. This is some 55 times the weight of the mole itself.

It is sometimes possible to see a mole hill being created. If you find an area where a mole is working underground, and you sit quietly, you may see loose soil appearing, like a miniature volcanic eruption, at the top of the heap. Unfortunately, if you arrive as the mole is stopping work, you may have to wait four or five hours while it sleeps and recovers its strength!

There is one useful tip which may make observation easier. The spoil thrown up contains small worms and other animals. Thrushes and blackbirds have realised they can obtain an easy meal on an active mole hill; by watching these birds at work you may be able to locate a mole.

When creating a mole hill, the mole uses a rhythm similar to that when it is tunnelling. You will notice an upsurge of soil, then another and another, at intervals of perhaps a second; one foot is being used. Then there may be a slight pause before the other foot comes into action and more soil appears.

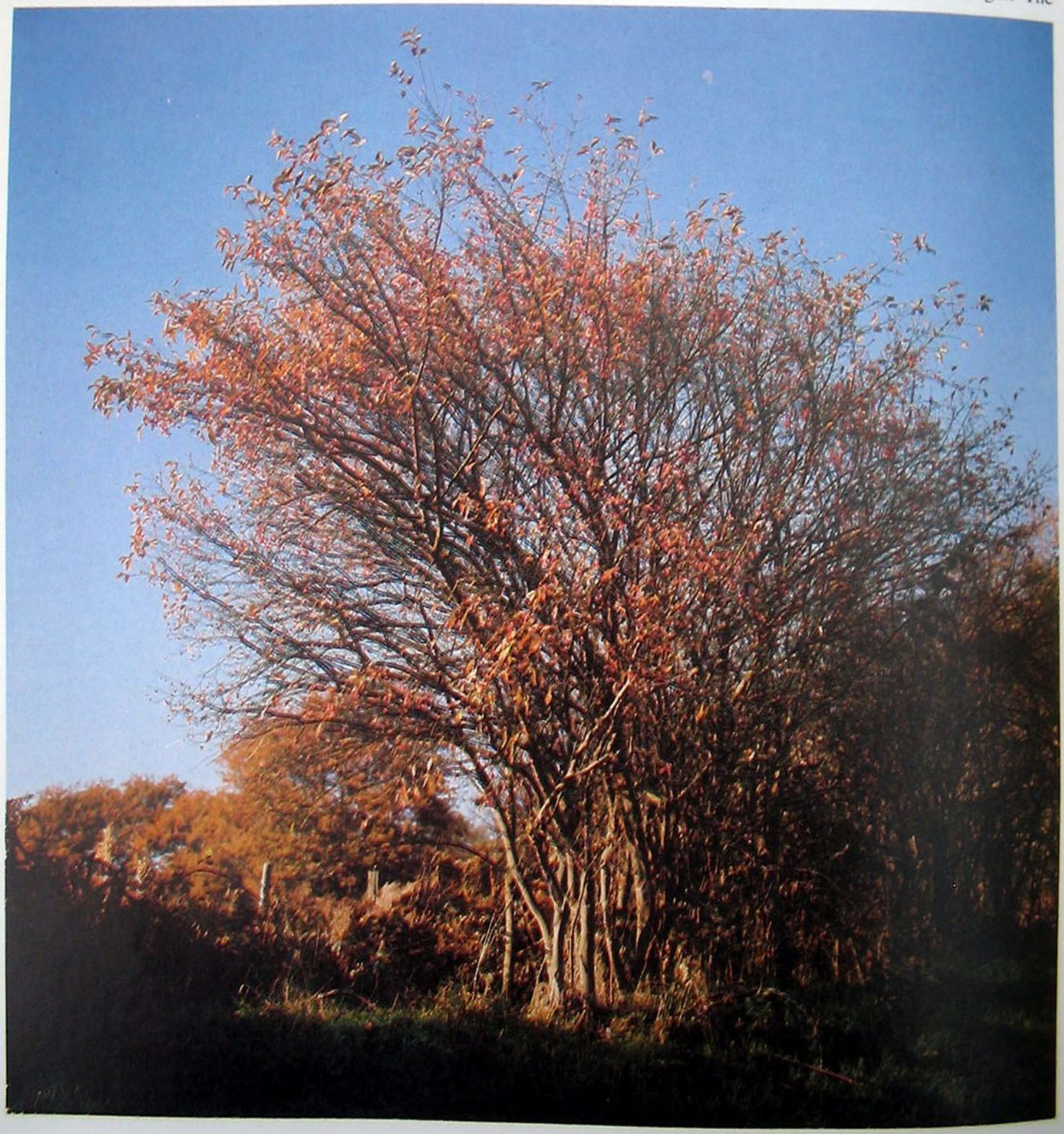
loose soil from burrow is pushed towards the surface to form a molehill
one forefoot is used to push loose soil
part of tunnel awaiting excavation
one forefoot and the hind feet are used to brace body against tunnel wall

SPINDLE: FLORID TREE OF AUTUMN

For most of the year the spindle tree grows inconspicuously in hedgerows and woodland. But in autumn it produces a vivid show of coral-coloured fruits containing seeds coated in bright orange flesh – an irresistible attraction to hungry birds.

The spindle is a shrub or small tree which grows in scrub thickets, open woods and hedgerows. It is most commonly found in chalk and limestone districts in the southern half of England and occasionally extends into northern England. But it is absent from most of Scotland and confined to a few localities in Ireland.

The younger twigs are green and have a rather square cross-section because the corners often develop a layer of corky bark which extends along the length of the twig. The stem and older branches are covered with pale brown bark. Each twig is tipped with a single greenish bud, and opposite pairs of buds grow along the length. The



Right: **Spindle tree** (*Euonymus europaeus*). Deciduous, native, grows to 5m (16ft) on chalk scrub, in woodland in S England, less common elsewhere. Flowers May, fruits Oct.

buds break into leaf towards the end of April and the leaves, each about 5cm (2in) long and spear-shaped with finely toothed margins, are supported on short stalks.

White flowers The spindle blooms during May and June, but it is easy to overlook the flowers because they blend so well with the foliage. They are usually grouped in threes and borne on short stalks near the tips of the twigs. The flowers are sometimes unisexual (either male or female), but usually bisexual (with male and female parts on the same flower). Four greenish-yellow petals and pollen-tipped stamens surround the central ovary, where the seeds develop after fertilisation.

The blossom is pollinated by insects–chiefly flies–which are rewarded with nectar. The stamens of bisexual flowers release their pollen some days before the female stigmas are mature enough to be receptive to it. Visiting insects are quite likely to transport pollen grains to flowers with mature stigmas, and cross-pollination then takes place. Self-pollination can also occur later when both the male and female sexual parts of the same flower are mature.

Coral splendour During winter and throughout spring and summer the spindle remains rather a drab, insignificant bush or tree. But in autumn it becomes vividly conspicuous because of its fruits. They are a striking deep coral pink and composed of four lobes, which are fused together. In October, as the foliage turns a variety of colours from deep crimson to purplish-brown, the berries split open to reveal the seeds embedded in a bright orange fleshy jacket (aril).

This gaudy display attracts birds to the bushes to feed on the arils, and the hard white seeds are dispersed in the birds' droppings. All parts of the tree are poisonous to man and livestock, but birds come to no harm.

The wood of the spindle tree is little used nowadays, but in the past its toughness made it valuable for making small durable articles such as clothes pegs, meat skewers and knitting needles, as well as spindles.

Spindle sticks Long before the spinning-wheel was invented, woollen thread for weaving was wound on to spindles made from twigs cut from the spindle tree. Women fed wool fibres from a fleece bundle through their fingers, so forming a thread which was then wound on to the spindle stick. One end of the shaft was wedged into a hole drilled through a stone, the weight of which, when twirled, gave the necessary momentum to keep the stick spinning. Twigs from spindle trees were ideal for this purpose because they are smooth, hard and not liable to splinter.

Opposite: The spindle tree in late autumn is easily recognisable for its coral-coloured fruits which contain bright orange fleshy seeds.

Right: Autumn fruits. The spindle tree's colourful fruits and autumn tints have been exploited in cultivated varieties, which are grown for decoration in many parks and gardens.
In some districts the fruits used to be collected, dried and ground into a powder which was rubbed into childrens' scalps to rid their hair of lice. The fruits earned the name of louseberries.

Below: The small white flowers of the spindle tree grow on short stems out of the leaf axils.

BASKING SHARKS

The best time to sight basking sharks – the second largest species of fish in the world – is on calm sunny days as they swim around the British coast. The shape of their fin above water is unmistakeable.

Observant holidaymakers at west coast resorts of the British Isles may often see the dorsal fin of a basking shark cutting through the water. The name 'basking' relates to the fish's habit of swimming near the surface. The Irish used to know the shark as sun fish. In summer, a basking shark will come remarkably close inshore – within 1-2m (3-6ft) of rocky shore lines, if the water is deep enough.

As the shark swims through the water, its dorsal fin tends to flop from side to side. The upper lobe of the tail fin is often visible above the water, moving with an S-wave motion 2m (6ft) or so behind the dorsal fin. When the fish swims well up in the water, the whole of the dorsal fin up to 1m (3ft) high is visible, and the snout sometimes projects above the surface. You can occasionally row right up to the shark and touch the dorsal fin when you will notice the body is surprisingly wide as it looms large beneath the bottom of the boat.

Slimy, scaly skin The skin above the water looks dark black; but the underwater parts of the body appear to be mottled in shades of grey and brown. The body exudes a vile, black slimy mucus, which can strip certain kinds of paint off metalwork, stain the sides of boats and cause hemp ropes and cords, as well as fishermen's nets, to rot. The black slime probably discourages many potential parasites. The skin also has tooth-like scales capable of inflicting serious grazes.

Gentle giant Following a basking shark by boat, as it swims along in absolute silence at about two knots, is not as dangerous as it sounds. For all its size it is basically a harmless and docile fish. In a five tonne specimen the brain is a mere 40g (1½oz), so the fish is not capable of any complex aggressive behaviour. Nevertheless it can dive at a terrific speed if startled, when the sweep of its tail could damage the boat. And if a basking shark met a boat head-on at full speed, it could easily hole the hull. However, it cannot sustain such sprint speeds for long without exhausting itself, and must soon revert to its normal, slow, meandering motion.

Not a mammal Nearly 9m (30ft) long and weighing about seven tonnes, the basking shark is recognised as the world's second largest fish. Its size has often led people to suppose it is a marine mammal related to the whale. It is, in fact, a fish breathing with gills which extract oxygen from the water. It has an upright tail in contrast to the horizontal tail of whales and dolphins.

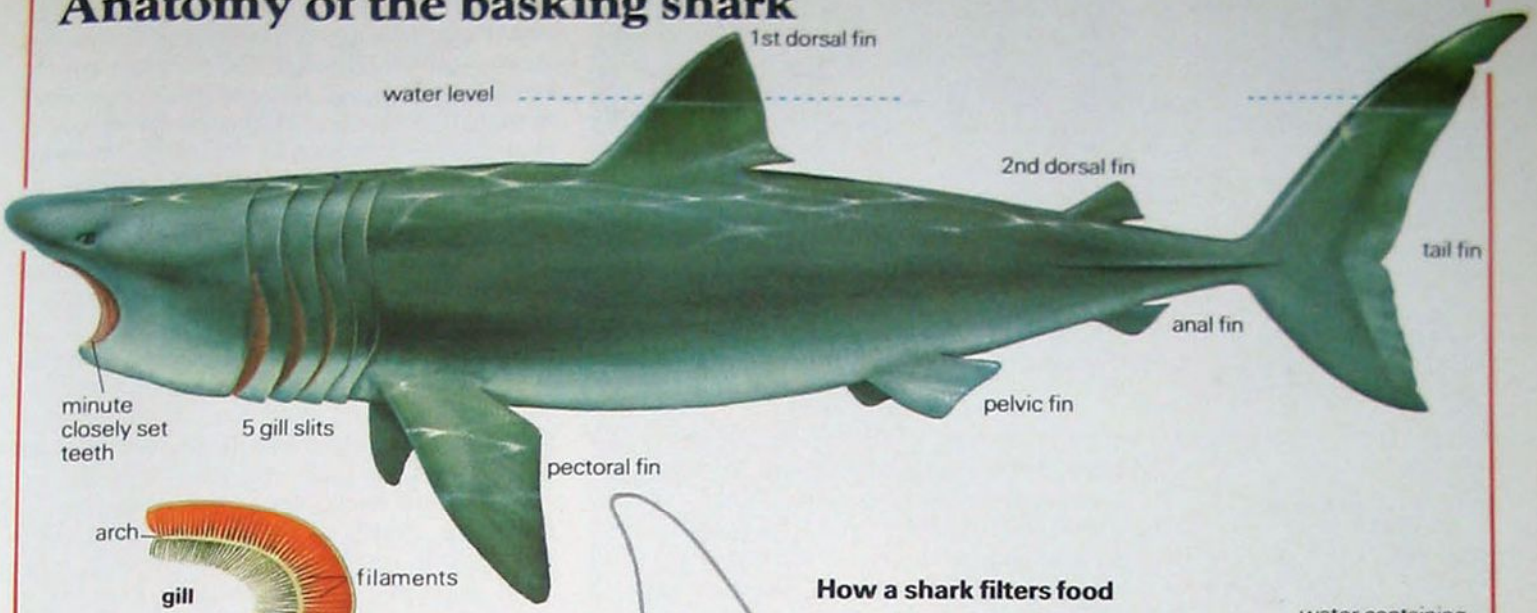
The body form is just a large version of smaller sharks, including dogfish (see page 124), and like all sharks the basking shark has a boneless skeleton made up entirely of cartilage. Basking sharks and whales have one thing in common – both are planktivores, feeding on vast quantities of drifting microscopic plankton in the summer months (see illustration). No large items of food are ingested as the shark has only minute teeth. Jellyfish sometimes get tangled in the gills, but no one knows whether they form a major part of the fish's diet. The stomach contents have the consistency of smooth paste, made up of millions of crustaceans.

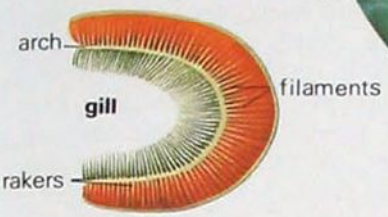
Mating and birth Little is known about the mating behaviour of basking sharks. But, as with all sharks, the male copulates with the

Above: The crew onboard this fishing vessel – involved in a satellite tracking project on basking sharks – caught this old female fish on the Clyde near Arran. They failed to lift the fish on to the deck however, because the winch couldn't take the shark's weight (around seven tonnes), and the jib wasn't high enough to lift the 9m (30ft) long fish out of the water.

Right: The basking shark's skin is covered with little flea-like creatures called parasitic copepods. These are about 15mm (⅝in) long, but the conspicuous twin trailing egg sacs can reach 50mm (2in). The skin, where irritated, seems to produce a white chalky material which makes these otherwise dull-coloured parasites quite noticeable.

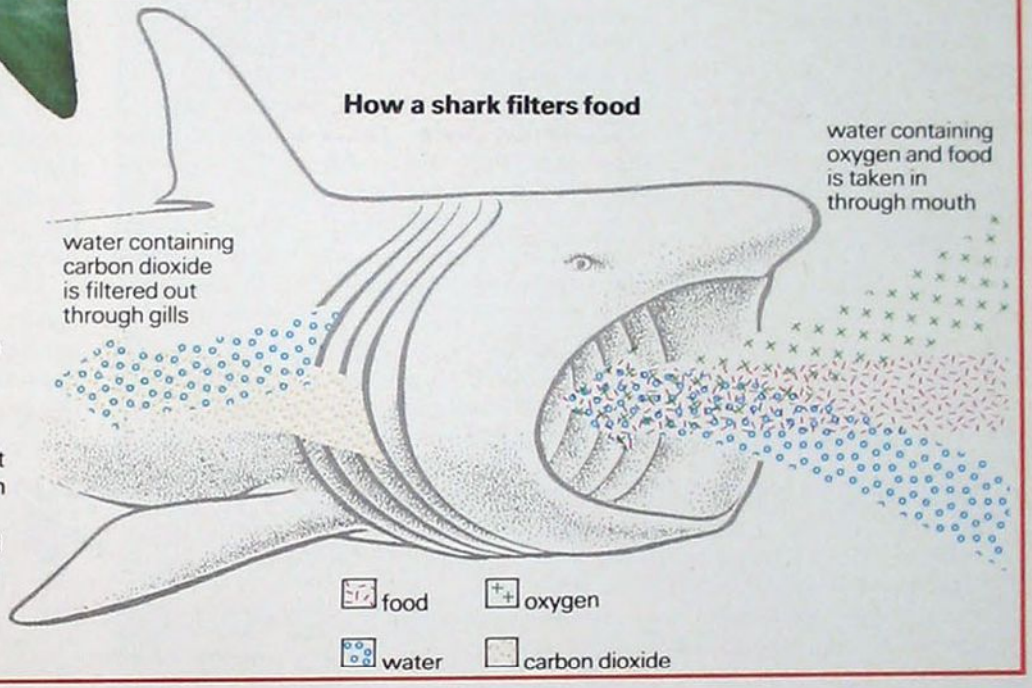
Anatomy of the basking shark





The basking shark's food is mainly minute shrimp-like crustaceans (copepods) that drift among the microscopic plankton. With its mouth gaping 70-80cm (about 30in), the shark takes in water and absorbs oxygen from it (right). Carbon dioxide is released into the water as it flows over the gills. Feathery rakers on the gill arches (above), which look like the bristles of a broom, filter food particles from the water. The fish can filter about 1500 tonnes of water per hour to obtain 1-2kg (2-4lb) of food.

How a shark filters food


water containing oxygen and food is taken in through mouth
water containing carbon dioxide is filtered out through gills
food
oxygen
water
carbon dioxide

female and fertilises her internally. The male has two claspers on the pelvic fins, either of which can be inserted into the female to transfer sperm. The clasper is equipped with hooks, and some females have been caught apparently suffering from damage caused by recent mating. It is estimated that the male produces about 50 litres of semen; the sperm is contained in translucent packets known as spermatophores.

Little is known of the development of the eggs after fertilisation. Despite the thousands of basking sharks that have been caught, no female has ever been seen by scientists with eggs or developing embryos inside her. However, in 1936 a Norwegian fisherman was towing a basking shark into harbour, when she gave birth to five live and one dead young. The fisherman caught one of the young and reported that it swam along with its mouth open, apparently feeding just like an adult. There was no sign of a yolk sac or navel cord. These newly born babies were about 1·5m (5ft) long.

Despite this evidence, the fact that basking

Right: Sea lampreys up to 60cm (2ft) long are regular passengers on the basking shark. They attach to the underside of the body with suckers, causing superficial damage and leaving circular marks on the shark's skin.

young

old

Above: You can tell the rough age of a basking shark by its dorsal fin. If the fin is quite pointed, the shark is quite young; if the fin is squarer, more worn and flops to one side, it belongs to an older fish.

sharks give live birth rather than laying eggs was not generally recognised until the 1960s. Although some shark species do lay eggs, most produce live young, and sharks are said to have 'invented' this form of giving birth millions of years before mammals appeared on land. There is considerable argument about the length of the gestation period. Some evidence suggests a period of over three years, but other research indicates a period of less than nine months. It is remarkable that pregnant females are never caught; where they go is still a mystery.

It is unlikely that basking sharks exercise any kind of parental care towards their young, which take ten years to mature.

Migration mystery Basking sharks are seen off our coasts during the summer – from April off Cornwall, and May or June off Scotland. This suggests a northward migration in the spring followed by a corresponding southward migration in the autumn. It is now thought that such a migration pattern is a misconception caused by schools of basking sharks simply coming to the surface at different times and at varying latitudes.

Basking sharks may winter in African waters; nobody is certain. As they occur throughout all oceans of the world outside the tropics, their migrations appear to be extensive. Against this, fisherman have caught sharks in winter, at deep levels just off the coast of Scotland and near their summer feeding areas. Therefore there may well be local stocks which do not travel very far.

A few fish have been caught that did not have gill rakers (part of the fish's filter mechanism inside the mouth which traps food particles – see illustration). This led to another mystery about the basking shark. However, all the rakerless specimens were caught in winter and further catches revealed fish shedding gill rakers in the autumn and others growing new ones in spring.

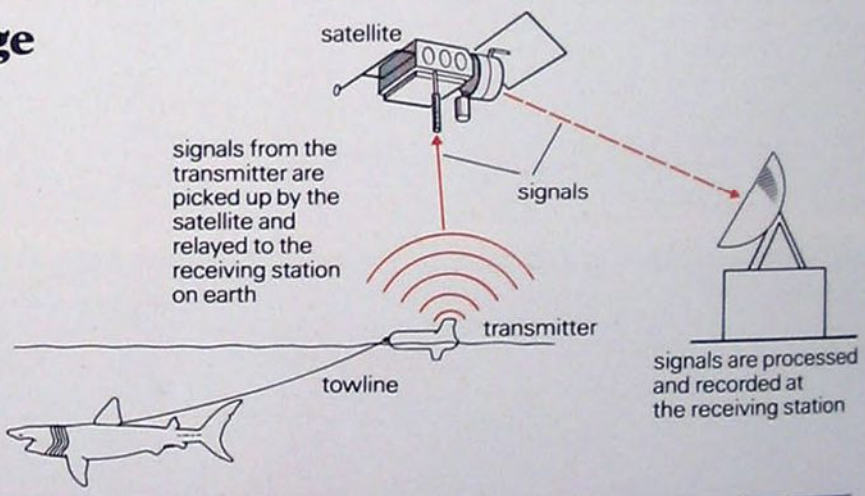
The basking shark seems to stop feeding in winter when it sheds its gill rakers, and probably lies on the bottom somewhere in deep water; but the position of these wintering grounds has still to be located.

Sharks enter the space age

Scientists at Aberdeen University have recently designed a special radio package to facilitate tracking of basking sharks. The package, which looks like a yellow plastic toy boat (below right), contains a powerful radio transmitter in a waterproof casing. Each package transmits a unique identifying code, which is picked up by a special radio receiver aboard a space satellite orbiting above the earth's atmosphere. The satellite retransmits the information to a ground station, where the position of the fish is automatically calculated and relayed back to the scientists waiting at Aberdeen.

The scientists carefully approach a surfaced shark on an inflatable boat equipped with a silenced outboard motor. They then inject a special stainless steel anchorage into the base of the shark's dorsal fin and attach a towline to this anchorage. The radio transmitter is connected to the other end and floats behind the fish when it swims on or near the surface. When the shark dives deep, the transmitter automatically switches off and is easily towed underwater by the shark. The transmitter and towline are shed after a few months, without any adverse effects to the shark.

This unique collaboration between space scientists and marine biologists will enable them to learn not only more about basking shark movements, but also how all plankton-eating fish find concentrated food supplies.


satellite
signals from the transmitter are picked up by the satellite and relayed to the receiving station on earth
signals
transmitter
towline
signals are processed and recorded at the receiving station

PERSISTENT URBAN FLOWERS

As summer draws to a close, you can find many flowering species – both native and introduced – that thrive in urban areas, spreading as colourful weeds.

The daisy family provides some of the most outstanding examples of the way native and introduced species have adapted to even the most apparently unpromising situations. The willowherb, plantain and poppy families are also well adapted to seemingly inhospitable habitats. Many species flourish in summer and well into autumn and they produce vast quantities of seeds, which is one reason for their wide distribution. They grow in good garden soil, on dry waste ground, in cracks on walls and even out of pavements. They thrive in the concrete jungle of urban areas, often supporting many different kinds of wildlife.

Orange hawkweed is a native species of Europe which is often planted in cottage gardens. A member of the daisy family, it produces numerous seeds; it also sends out stolons which straggle across the ground, forming a new rosette of leaves at their tips. These stolons can grow as much as 30cm (12in) in a season, and the plants soon spread themselves far beyond their original habitat. The orange hawkweed's generic latin name *Pilosella* means 'the hairy one', which is appropriate for all its parts are covered in bristly hairs. The small orange-red flowers eventually form deep crimson ribbed fruits which contrast with the pale pappus hairs.

Thistles The creeping thistle and spear thistle validate the saying that 'there is more to thistles than prickles'. Both have been found in Palaeolithic deposits. The creeping thistle has a tap root with lateral roots growing horizontally from it. Once established, this species is extremely difficult to eradicate. The tap root can be as much as 2.5m (8ft) deep and, if even a few inches of the root are left in the soil, a new plant will soon develop.

Above: **Orange hawkweed** (*Pilosella aurantiaca*) flowers June-Sept in gardens and waste ground. Ht 50cm (20in).

The creeping thistle also grows easily from seed. The rose-purple flower heads, each with about 100 separate florets, have an abundant nectar supply and the sticky pollen is avidly gathered by bees, which are the main pollinators. The brown shining fruit is topped by a long conspicuous feathery pappus. Of the seeds produced in summer, some may germinate in late autumn of the same year, and others the following spring. By being so versatile this most persistent perennial weed may take over abandoned fields and waste ground, making it difficult for other species to colonize the area.

The spear thistle is less of a problem to eradicate as it is a biennial. Its bright purple

Insect eye's view

Many flowers have honey-guides on their petals to attract insects to the nectar source. Good examples are the pansy and horse chestnut. Yet not all honey-guides are visible to us. Some are visible only in the ultra-violet light to which bees and many other insects are sensitive. When a plant is photographed in ultra-violet light a wide range of different patterns are revealed to us. The basic colours a bee can see are yellow, blue and violet. To a human the evening primrose is yellow, but to a bee it appears to be coloured purple. Bees seem to like vivid colour contrasts.

flower heads mature quickly and the numerous seeds are dispersed on the wind. They germinate in autumn and over-winter as a rosette of spiny leaves. By spring the species is much more obvious. The grooved stem is covered in large prickles, and the leaves, which have woolly undersides, terminate in a long spine reminiscent of a spear. The shiny fruits are yellow-brown with grey streaks.

Both these thistle species are hospitable to wildlife. The fruits of the spear thistle are eaten by beetle larvae, and the spiny black larvae of painted lady butterflies live and feed on the woolly leaves of the creeping thistle. In autumn you also see roundish galls on the creeping thistle; these are caused by fruit flies.

The garden marigold, which was introduced to the British Isles from southern Europe in the 16th century, now often grows as a garden escape on nearby waste ground. With its nectar-filled central florets, this old-fashioned single garden marigold attracts insects, particularly bees. (The modern cultivated double orange varieties lack the central florets and do not reproduce so freely.)

The greater plantain is another species that has been found in Palaeolithic deposits. It is a common perennial weed that varies in size, depending on its environment. In pavement cracks it is no more than a few centimetres high; in fertile soil it may be 30cm (12in) across, and 60cm (24in) high. The oval leaves are ascending, with prominent ribs. The inconspicuous brownish flowers have purplish anthers and are usually wind-pollinated, although bees and other insects sometimes visit them for pollen. The capsule contains many seeds, which are attractive to birds, particularly pigeons.

Yellow corydalis is an erect or spreading tuberous perennial from Europe which has much divided, delicate, pale green leaves and yellow spurred flowers. Its glossy black seeds are too heavy to be wind-borne, yet surprisingly many plants are found on walls a few metres up. The possible answer lies in the fact that the seeds have a fleshy, oily, edible part attractive to ants, which carry them off to their nests above or below ground level. Birds may also distribute the seeds in their droppings.

The large-flowered evening primrose is found naturalised as a garden escape; it probably originated in the British Isles in the mid-19th century and may have come from North America. Its hairy buds open into a four-petalled golden flower which becomes reddish as it matures. The flowers of this biennial open at dusk, their strong fragrance attracting night-flying insects. Bees also visit them to collect pollen, especially in the early morning. The pollen grains are bonded by yellow threads that may become attached to the bees' legs. The stems and the leaf midribs are usually red; but it is a variable species, and you often see mutations.

Left: Creeping thistles produce hundreds of seeds, which are blown on the wind, making them one of our most persistent weeds and hard to eradicate.

Spear thistle (*Cirsium vulgare*) flowers July-Sept in grassland and waste ground especially in chalky areas. Ht 1m (39in).

Creeping thistle (*Cirsium arvense*) flowers July-Sept in fields, waysides and waste places. Very common. Ht 90cm (35in).

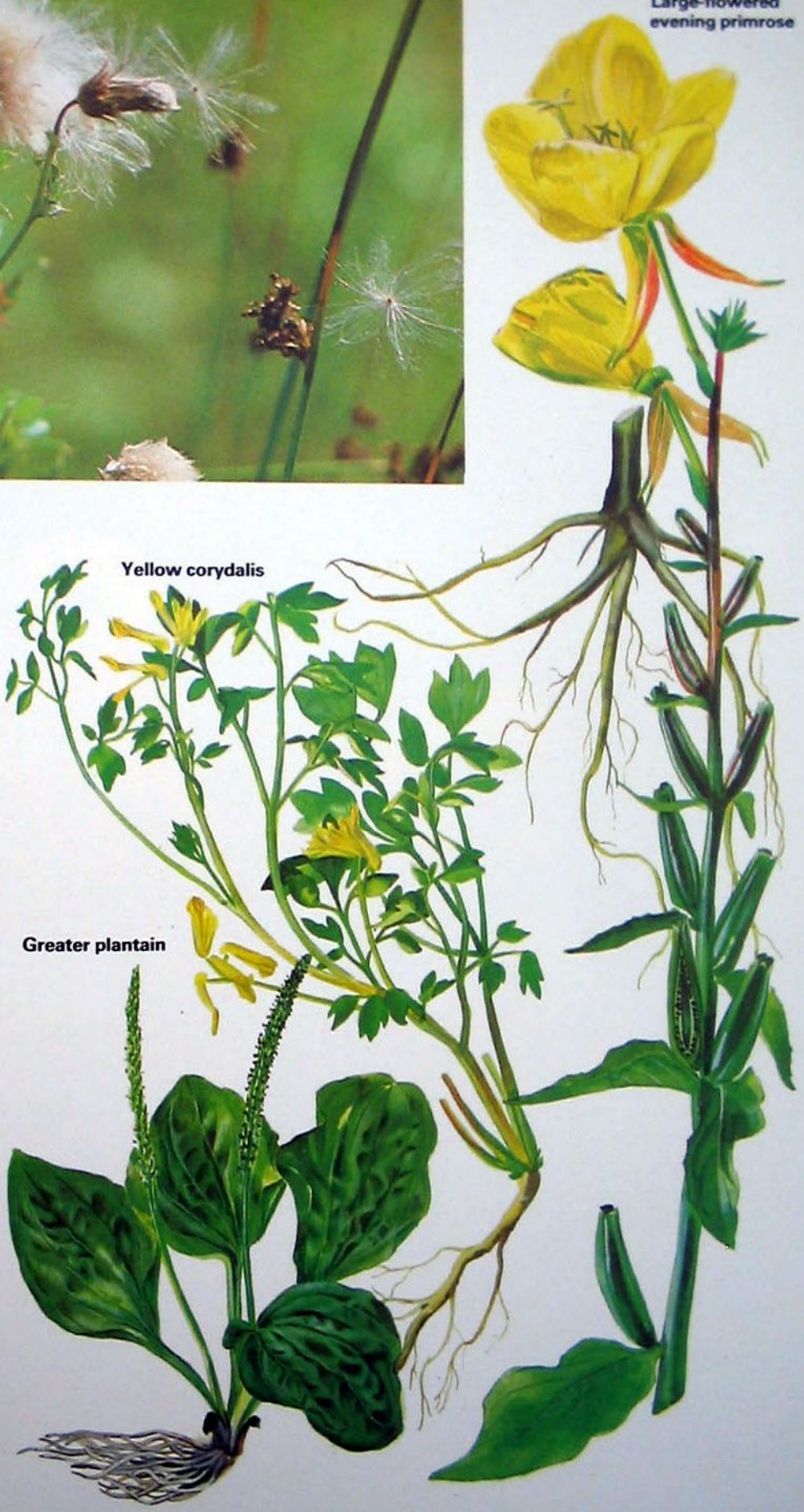
Garden marigold (*Calendula officinalis*) flowers June-Oct in gardens and waste ground. Ht 45cm (18in).

Smooth hawk's-beard (*Crepis capillaris*) flowers June-Sept in grassland, heaths, waste places. Very common. Ht 50cm (20in).

Greater plantain (*Plantago major*) flowers May-Oct in short grass, by roads, in farm lanes and cultivated ground. Ht 15cm (6in).

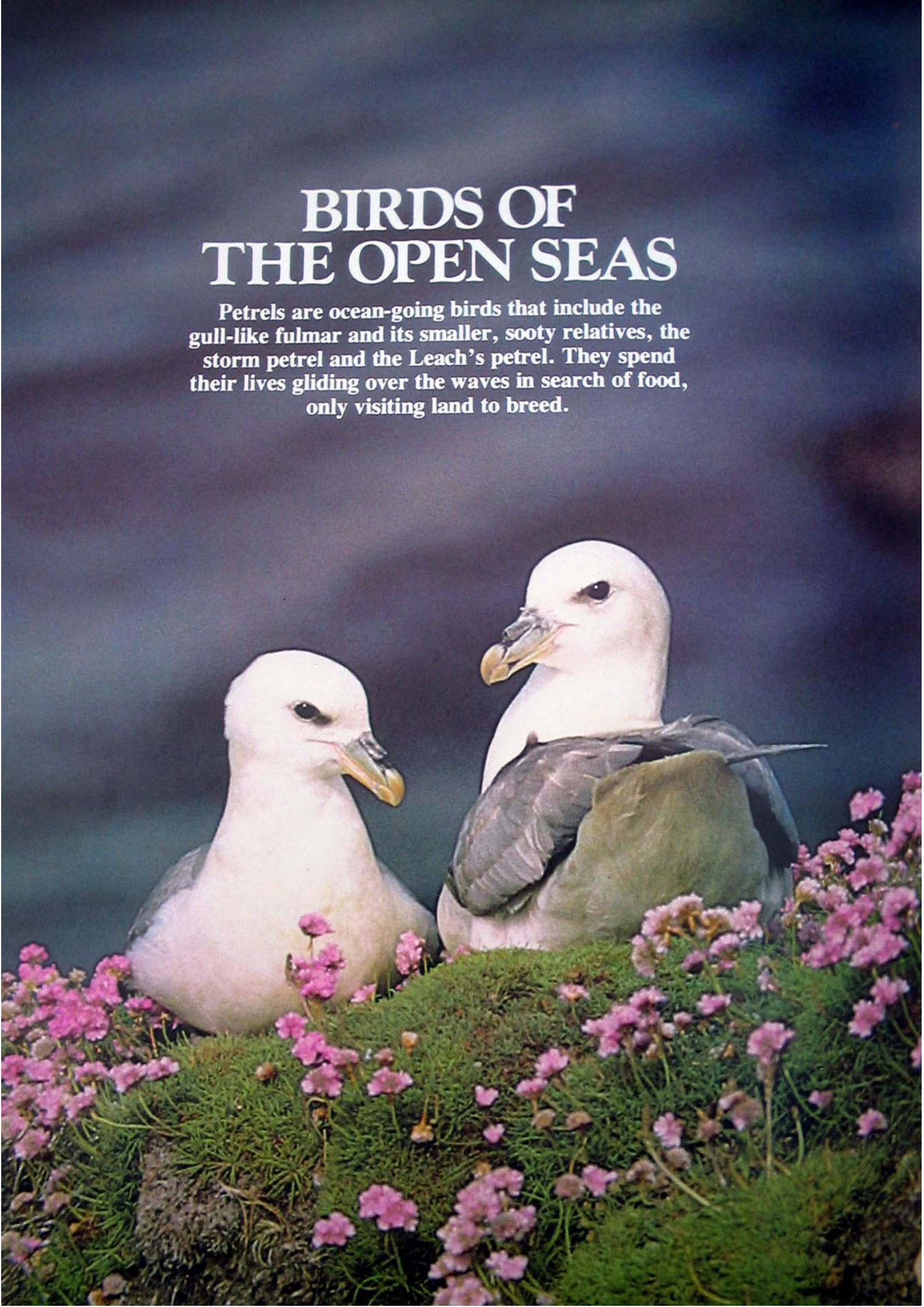
Yellow corydalis (*Corydalis lutea*) flowers May-Sept in gardens and as a garden escape on walls, in pavements. Ht 20cm (8in).

Large-flowered evening primrose (*Oenothera erythrosepala*) flowers June-Oct in gardens, waste ground, sand dunes, railway banks. Becoming more widespread. Ht 80cm (30in).



BIRDS OF THE OPEN SEAS

Petrels are ocean-going birds that include the gull-like fulmar and its smaller, sooty relatives, the storm petrel and the Leach's petrel. They spend their lives gliding over the waves in search of food, only visiting land to breed.



Gliders and flutterers

The fulmar, together with the storm petrel and the Leach's petrel, are all related to that giant among oceanic birds, the albatross, as well as to the shearwaters, aptly named after their habit of skimming low over the waves.

The fulmar looks completely different compared to the other two petrels. It is about double the size of its relatives, mainly white and much like a gull. It nests on open cliffs and in summer can be seen all day long near the coast. The storm petrel and the Leach's petrel, on the other hand, are quite small for seabirds (lighter in weight than a song thrush) and are sooty black all over save for a white patch on the rump. They come ashore to their nests, in deep burrows or natural crevices in the rocks, only after dark.

Tubular beaks All petrels are distinguished from other seabirds by their complex beak structure. Viewed close up, the beak is made up of a series of plates of horny material, with clearly visible joints or sutures in between. In addition, the ridge of the beak is topped with a horny tube that gives the group another colloquial name–the 'tube-noses'.

The precise function of this narrow tube is not properly understood. One theory is that it serves these seabirds–most of them extremely efficient high-speed gliders–as an air-speed indicator, in much the same way as does a 'Pitot tube' on a modern aircraft. Another theory suggests that it functions as a genuine nostril. The sense of smell is poorly developed in most birds, but many petrels emit a powerful, musty odour, and returning birds may possibly 'scent out' their mates not only after dark but also deep in nesting burrows.

Success story The fulmar is at the centre of one of the most amazing bird success stories of the last 100 years. For over 900 years, the only known British breeding station was on the remote island of St Kilda, 50 miles west of the Outer Hebrides. Then, in the middle of the 19th century, the Icelandic fulmar population began to expand, and in 1878 other colonies began to be reported on Scottish islands, the first on Foula.

Since then, there has been no stopping the birds extraordinary spread. First the northern islands were colonised, followed by the cliffs of both the east and west coasts of Britain and Ireland, until by 1970 fulmars were nesting on all suitable stretches of rocky coast. Even in some apparently quite unsuitable areas they find a way to succeed. In the Hebrides, there are now nests on the ground in remote and undisturbed sand dunes, and on the cliff-less coasts of southern and eastern England. The birds have even commandeered nuclear power station window sills as the nearest alternative to a cliff ledge.

Fulmars have also moved inland. Nesting was first reported on ruined buildings in the Shetlands, but now quarries several miles from the sea in northern England have breeding pairs.

There is no certain reason for this success. It may be that there was a sudden genetic change in the birds themselves, or that the North Atlantic warmed slightly and produced more fish. A more likely explanation is related to the fulmars' diet, which consists mainly of offal. The rise in numbers coincided with the time when whaling reached a peak in the Atlantic–with abundant supplies of offal both at sea and near the shore. Although whaling has now been curtailed, modern fishing (with a great deal of the catch gutted at sea) has taken over this food-providing role.

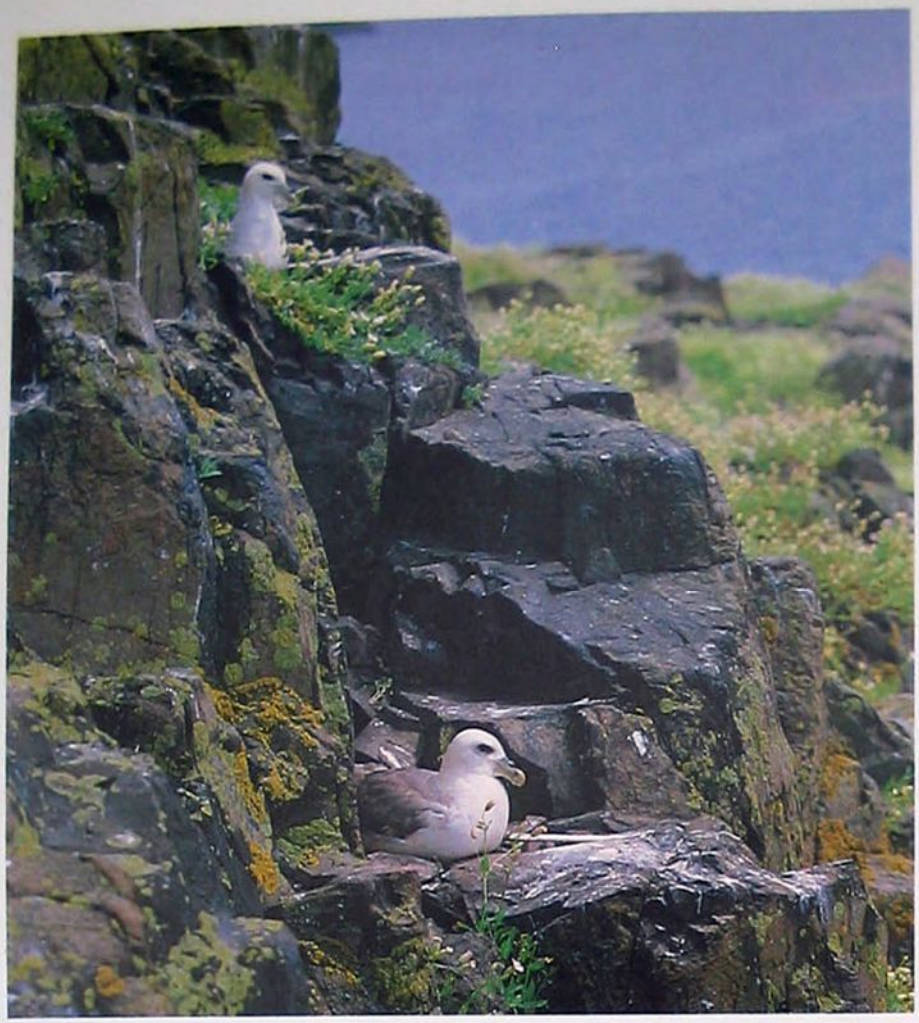
Fulmar (*Fulmarus glacialis*), 47cm (18½in) from beak to tail. Long stiff wings, grey upper parts, white underparts.

Storm petrel (*Hydrobates pelagicus*), 15cm (6in) from beak to tail. Pale wing bar, white rump, squarish tail.

Leach's petrel (*Oceanodroma leucorrhoa*), 20cm (8in) from beak to tail. Diagonal paler wing band, white rump with dark stripe, forked tail.

Above: The fulmar slices through the air like a guided missile, while the much smaller storm petrel, resembling a large black moth, flutters feebly on an erratic flight path. The Leach's petrel is more positive in flight, but retains the erratic flight of its smaller cousin.

Opposite: At their nesting site on an open cliff, fulmars will 'spit' a foul smelling fluid (regurgitated from the stomach) to deter any intruders.



Slow breeders The fulmars' success is particularly surprising in the light of their low reproductive capacity. Once they have fledged from their simple cliff ledge nests, fulmars remain 'adolescent', roaming around the North Atlantic, for at least five years. After this period they visit the cliffs in spring and summer – prospecting for a nest site and seeking a mate – for another two or three years before they breed for the first time at about eight years old.

Only a single large chalky-white egg is laid, and this often cannot be replaced if it, or the chick, is lost to a predator. And these losses do occur, despite the fulmar's vigorous defence of its nest (see the box on aggression).

Long life The dangers inherent in such a lengthy breeding cycle seem to be offset by the lifespan of this bird. (Research workers have found it difficult to make a ring strong enough to resist the abrasion caused by the fulmar shuffling about awkwardly on the rocks.) But those results obtained from detailed studies by Aberdeen University suggest that many fulmars live for as long as 30 years, and a proportion may be a good deal older. At that rate, even laying only one egg a year, the fulmar pair have ample time to produce offspring several times over and ensure the population explosion that we have witnessed.

Fulmars in flight Out at sea or twisting and turning in the eddies and updraughts near

Aggression in birds

Birds normally resort to aggression only to protect their breeding territory from competitors, or defend their feeding areas from predators. Competition between birds is almost always confined to birds of the same species, other birds being tolerated or ignored. The response to predators varies. Starlings, for instance, just gather and swoop around – or 'mob' – a hunting kestrel, while the meadow pipit may press home an attack against a marauding cuckoo to the point of causing feathers to fly.

The fulmar is unusually well equipped to repel intruders. Once in its digestive system, the fulmar's plankton food is converted into an oily and smelly fluid. The fulmar can 'spit' this with great accuracy at predators venturing near its nest – even at several metres range. Sometimes it will pursue an intruder and 'shoot it down' in mid-air, the predator landing immediately and preening vigorously to remove the foul-smelling oil that is clogging its plumage.

Most birds, however, rely on plumage and posture to convey their aggression. The fluffed-up cock blackbirds patrolling each side of the invisible boundary between their territories are a good example. Robins use their red breasts to warn rivals off their territory (see page 32), even going to the extent of attacking with great ferocity stuffed 'model' robins placed in their territory by researchers.

Above: These fulmars are nesting among the rocks and flowering sea campion on the island of Inner Farne, off Northumberland.

Right: The fulmar lays only one large, dull-white egg in its clutch, usually in some sort of surface hollow. Incubation – at around 50 days – is long and potentially hazardous.

Below: This young Leach's petrel, a ball of sooty down, is hidden in a burrow excavated by the parents.

their nesting cliffs, fulmars provide the birdwatcher with a flying spectacular. They are expert gliders, rarely flapping their wings except on a still day. Gull-sized and grey and white in colour, they may look rather dumpy with short, slender and stiff wings held slightly down-curved. But they are very well streamlined. Their large eyes are set deep in grooves in the feathers and, except when the birds are on the nest, the feet are normally concealed, tucked up out of the way in the body feathers.

Near the cliffs, fulmars use their webbed feet to assist in steering or to make fine adjustments to their flying techniques. They seem able to take advantage of any wind, cutting at speed diagonally across the wind and also downwind in a shallow dive before turning sharply into the wind to gain height again. They then repeat the process. Even the slight up-currents raised by the face of oncoming waves are exploited to give that extra bit of 'free' aerodynamic lift.

Storm petrels are sooty black, save for a white patch along the rump which divides off the square, black tail. They nest on many islands to the west and north of Britain–and often apparently enormous numbers can be heard purring in their burrows. However, any census of these small black birds, which nest in holes and come ashore only after dark, is difficult to carry out with much accuracy.

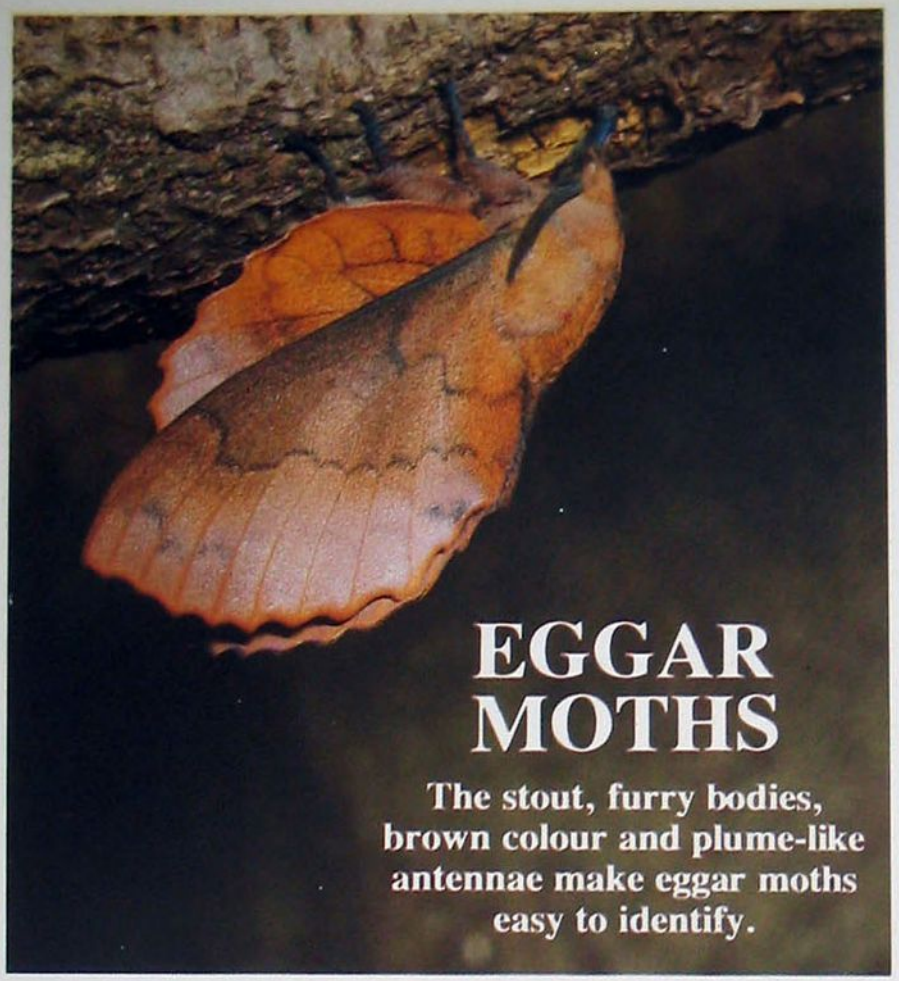
The Leach's petrel is slightly larger than the storm petrel, with a grey patch on the wing, a forked tail and a dark line down the centre of its rump. One of our scarcest birds, it nests only on a handful of remote islands like St Kilda, where its wild whooping and whistling song can sound quite chilling to the birdwatcher.

Nocturnal activities Towards dusk petrels journey back home to land, either loaded with plankton food for their single dark, fluffy offspring, or anxious to relieve their mate incubating the small, almost spherical white egg. Before they enter their nest these birds gather offshore to await the dark and the safety that darkness brings from predators such as the great black-backed gull.

In winter, these small petrels truly become birds of the open sea (pelagic). They cover the oceans in their search for minute food items from the surface plankton, which they gather while swimming or by dipping down to the waves in flight. Often storm petrels follow in the wake of ships, sometimes pattering their feet on the surface, for mile after mile in the hope of collecting a meal from the scraps tossed overboard. In the days of the sailing ships this habit endeared them to sailors on long voyages and earned them the name 'Mother Carey's chickens'–the reason for which remains obscure, but probably refers to *Mater Cara*, the sailors' name for the Virgin Mary.

Above: The storm, or stormy, petrel is among the smallest and most fragile of seabirds. It touches land only during the breeding season, and then only from dusk to dawn. At other times it is a truly oceanic bird, often following ships in pursuit of scraps, and skimming low over the water.

Below: From humble beginnings nearly 1000 years ago on the island of St Kilda (circled in red), the fulmar population has now spread dramatically round the British coast.



EGGAR MOTHS

The stout, furry bodies, brown colour and plume-like antennae make eggar moths easy to identify.

Above: A female lappet moth. Its close resemblance to a cluster of dead, shrivelled leaves gives it effective camouflage. Both sexes are attracted to artificial light and sometimes fly into houses.

In the British Isles there are 11 species of eggar moth. Their family name 'eggar' refers to the hard, egg-shaped cocoons spun by the extremely hairy caterpillars of some species from silk mixed with their own hairs. The hairs protect the caterpillars from most predators–the cuckoo being one of the few birds to relish them–and can cause considerable irritation to your face and neck.

The life cycles of the fox, oak and northern eggars, drinker and lappet moths are broadly similar in that their caterpillars hatch from eggs laid in summer and hibernate when still very young (except those of the fox, which do so only when full grown), emerging to feed again in spring. The lackey moth differs from the others in that its caterpillars hatch in spring.

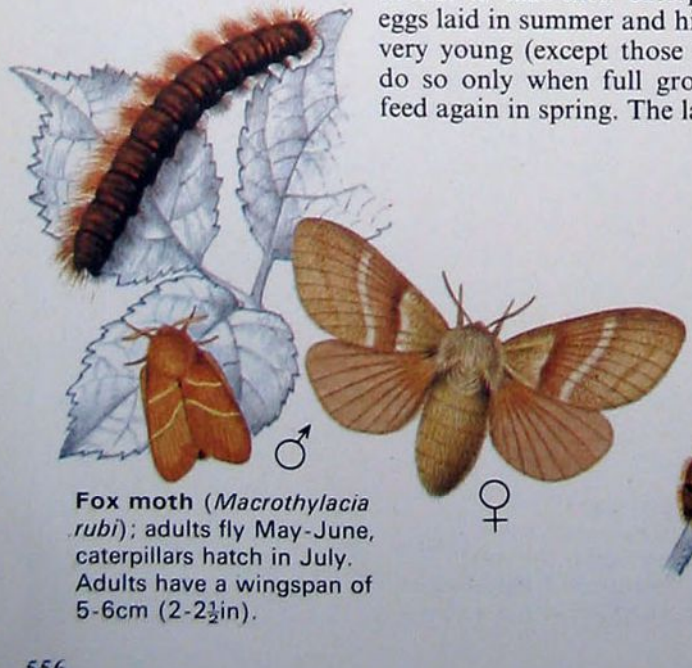
Fox moth caterpillars do not feed again on emerging from hibernation. For a while they bask in the sun, often resting fully exposed on their foodplants–heather, heaths, bilberry and brambles–until March or April when they descend to the roots of the plants to spin their brownish elongated cocoons. Within these stout cocoons they turn into brown pupae.

In May or June the adult moths emerge. The females are inactive by day and sit about in the herbage. Here they are sought by the highly active males which, flying in a rapid and erratic manner in the sunshine, home in on the scent the receptive females emit. After dark, the females take flight and lay batches of brown and grey eggs on the stems of the foodplants. The fox moth can be found on heaths, commons and moors.

The oak eggar is more or less common throughout the British Isles. On the heather moors of Ireland, North Wales, Scotland and northern England a darker race of this large moth occurs. Known as the northern eggar, it differs from the southern race in usually taking two years instead of a single year to complete its life cycle. Thus these moths appear earlier in the year (May and June) than those of the southern form, which fly in July and August along woodland borders and hedgerows and over heaths and coastal dunes.

When the oak eggar caterpillars hatch in August, they feed on a wide range of plants, such as bramble, broom, sallow and hawthorn, until they pupate the following June or July. The northern eggar caterpillars, on the other hand, though feeding on these plants as well, show a decided preference for heather. They go into hibernation in the autumn, feed slowly through the succeeding summer, and hibernate for a second winter before finally pupating in early spring. In both races the pupae are purplish-brown and lie within tough, yellowish, egg-shaped cocoons held among ground vegetation by silken strands.

As with fox moths, oak eggar males career



Fox moth (*Macrothylacia rubi*); adults fly May-June, caterpillars hatch in July. Adults have a wingspan of 5-6cm (2-2½in).

Oak eggar (*Lasiocampa quercus*); adults fly July-Aug, caterpillars hatch in August. Adults have a wingspan of 5-6·5cm (2-2½in).

Left: The caterpillars of the lackey moth are very gregarious and live in tent-like silken webs, coming out in swarms to feed on surrounding foliage.

about in the daytime, seeking out unmated females by their powerful scent. The females fly in late afternoon, scattering their greyish eggs, mottled with brown, at random.

The drinker moth, whose name comes from its partiality for dew drops, rests during the daytime and flies at night–in July. It frequents open country in many parts of the British Isles, especially damp or marshy localities where the handsome caterpillars feed on the leaves of reeds and various grasses and sedges. The eggs from which they hatch are white and shiny, marked with grey, and are laid in batches on the stems of the foodplants. The pupating caterpillars spin their elongated ochre or light brown papery cocoons on the foodplant stems.

Lappet moths, which fly at great speed along hedgerows and the edges of woods at night in July and August, are often attracted to light. These moths are plentiful only in the south of England.

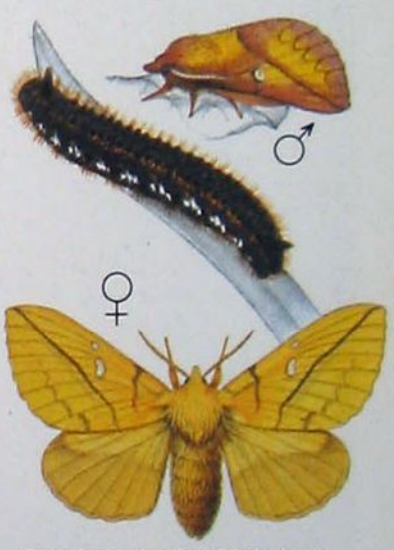
The female lappet, which is much larger and paler than the male, lays her whitish eggs, spotted and banded with grey, in pairs or small batches on the twigs or foliage of the caterpillars' foodplants (various fruit trees and bushes such as plum and blackthorn, as well as hawthorn and sallows). The caterpillars, with fleshy lappets over their legs, grow surprisingly large; but they are well camouflaged when resting by day on the woody stems of their foodplants, to which their long, grey cocoons are fixed.

Lackey moth caterpillars differ from the other species described here not only because they hatch from their eggs in spring instead of the previous autumn. They also live gregariously for much of their life in coarse, tent-like silken webs which they spin among the twigs of their foodplants–various trees, including blackthorn, hawthorn, and oak.

From the web's shelter the caterpillars swarm out to feed on the surrounding foliage, returning to sleep or sun themselves or moult. When fully grown they separate and spin double silk cocoons among the leaves. The caterpillars are brightly striped like a footman's livery in red, blue and black, warning potential predators they could be poisonous, and certainly distasteful.

Lackey moths are on the wing at night in July and August in open country in most parts of England and Wales, except the northernmost counties, and are absent from Scotland. The larger, stouter-bodied females deposit their glossy brown eggs in batches around twigs on the foodplant.

Lackey moth (*Malacosoma neustria*); adults fly July-Aug, caterpillars hatch in April. Wingspan of adults is 3-4·5cm ($1\frac{1}{4}$-$1\frac{3}{4}$in).



Drinker moth (*Philudoria potatoria*); adults fly in July, caterpillars hatch in August. Wingspan of adults is 5-6·5cm (2-$2\frac{1}{2}$in).

Lappet moth (*Gastropacha quercifolia*); adults fly July-Aug, caterpillars hatch in August. Adults have a wingspan of 6-7·5cm ($2\frac{1}{4}$-3in).

Northern eggar (*Lasiocampa quercus callunae*); adults fly May-June, caterpillars hatch August. Adult wingspan as oak eggar.

THE HEDGEROW AT HARVEST TIME

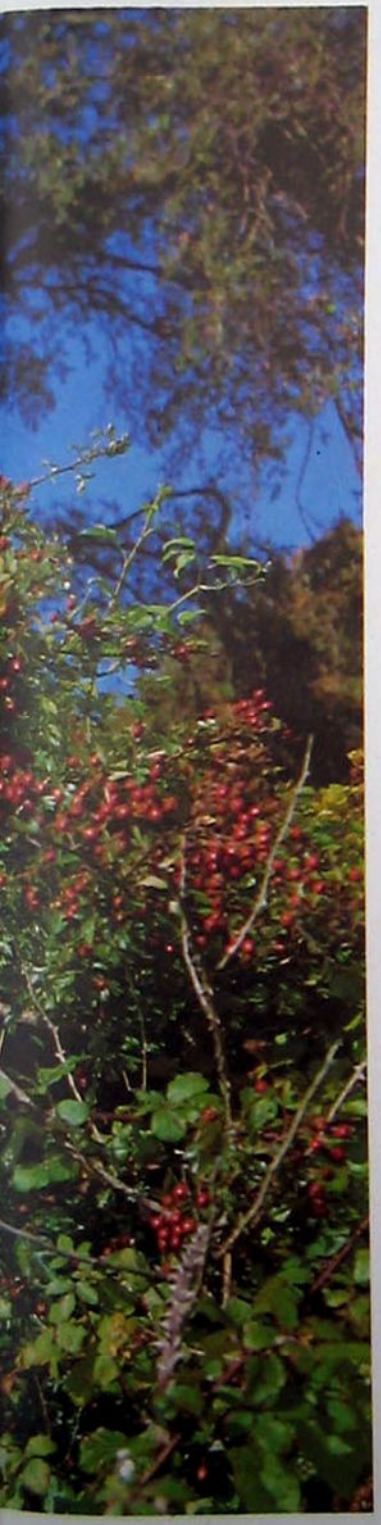
As the season begins to turn the hedgerow plants change in colour, while a plentiful store of fruits ripens for both the residents and the visitors. Plants will soon die back, so animals must start their preparations for the bleak months ahead.

An early hint of the change of season is given when the first autumn tints appear. The food-making work of the leaves is now nearly done, and the green chlorophyll is beginning to break down, revealing other pigments which have, until now, been masked. In some trees the green colour begins to fade from the edges of the leaves; in others the change begins in the leaf veins. In oak the pattern is less predictable, brown patches appearing at random over the leaf surface. Inside the joint where each leaf is connected to the stem, a thin layer of cork forms: this seals the veins, and sooner or later the leaf falls.

Autumn decay In the autumn hedgerow the

Right: When fruits ripen, the long-tailed field mouse collects a store of berries, haws and nuts, which it often keeps in an abandoned nest. It will return from time to time in the coming months to feed here.

Below: An example of the more luxuriant type of hedgerow. In autumn, the white heads of clematis seed and the plentiful hawthorn berries provide an immense harvest for wildlife.



process does not stop there. The nutrients that the hedgerow plants have taken from the soil to build up complex substances will now be broken down and returned to the soil. This ensures that they will once again be available for the plants to utilise next spring.

Decomposition takes place in a variety of ways. Some plants and many fungi actually live on dead and decaying matter (including other plants): these are called saprophytes and play an important part in the breakdown of plant material. Many of the decomposing agents are invisible to the naked eye–the teeming millions of bacteria, for example. Others, such as some of the fungi including moulds, are more readily seen. White threads abound in the leaf litter: these are the spreading branches (hyphae) of fungi. Many species of fungi never appear above ground level, but remain in this thread-like form. Only some are able to put up the fruiting bodies that we know as mushrooms and toadstools.

Gathering the harvest Although growth in the hedgerow is slowly coming to a halt, it is by no means a deserted place. Man and beast come for their spoils, searching out the fruits and berries which are the end product of the plant growth of previous months. For country folk the hedgerow was important in the past. It was a veritable treasure house: a source of food, drink, medicine, shelter, fuel and dyes.

So many hedgerow plants satisfied man's needs that numerous superstitions have arisen. Of the hedgerow fruits, blackberries are particularly sought after by people and animals alike. According to tradition, however, it is unsafe to gather them after Michaelmas for that is the time the devil, as he was being kicked out of heaven, spat on the blackberry bush in his rage!

Today we collect blackberries by the basketful for pies, jams, jellies and wine: animals take them too, attracted by their sweetness. Wasps will be out on their final desperate hunt for food before the cold and damp kills them. Strong mandibles tear away the tough outer skin, exposing the juicy flesh underneath. This is an open invitation to many other invertebrates to take their fill. Various species of vinegar fly will eat from the damaged fruit; they share their harvest with bluebottles, greenbottles and drone flies. Red admiral and speckled wood butterflies can sometimes be seen taking the blackberry juice.

Other insects come for different reasons. The eggs laid by various insects in the bramble flower heads will now have hatched, providing hosts for the parasitic ichneumon wasps. The female ichneumon lays her eggs inside the bodies of the larvae. These eventually hatch, and the unfortunate hosts are literally eaten alive.

Fallen blackberries provide rich pickings for many mammal species. The bank vole and wood mouse take their share, and the badger also finds time on his nightly patrols to savour them. Dispersal of the seeds by these mammals and by birds is a way of ensuring that new plants will grow in other areas.

By mid-autumn the blackberries have lost their appeal, but are still attacked by moulds, which further assist in the decay process.

The white may blossoms of the hawthorn have given way to red berries (haws) which are succulent and nutritious to birds, including those winter visiting members of the thrush family, the redwings and fieldfares.

Insects visiting the hedge for autumn fruits provide a meal for the opportunist spiders. Webs may look empty, but somewhere a spider waits for its prey. Those

created by the orb web or garden spider are numerous and especially attractive. Other spiders produce hammock-like constructions beneath them for their prey. As an insect lands, the spider bursts into action, pouncing on its prey. All species use the same tactics for dealing with the prisoner. The fangs inject deadly poison into its body. Sometimes the prey may be eaten immediately; sometimes it may be wrapped in silken threads and stored away, to be devoured later.

Mammal beneficiaries The autumn hedgerow harvest attracts small mammals: they collect more than they need, storing the excess for less prosperous times. The long-tailed field mouse, an inhabitant of the hedgerow normally resident in secret homes in the dense hedge bottom, takes a variety of nuts and berries, including hawthorn, wild rose, rowan and hazel. There is usually a plentiful supply of these in the hedge bottom, having been accidentally dropped by other hedgerow foragers. Should the need arise, however, the mice will climb up into the hedge to bite through stems holding berries. They may stay there to eat, perhaps using a disused bird's nest as a table, and many an unoccupied blackbird or thrush nest bears witness to their autumnal feasts. At the bottom of the nest lies a debris formed of the shells of hazel nuts, nibbled acorns, empty seed cases and the flesh of haws, often marked with stains from elderberries.

Quarrelsome and noisy shrews make regular patrols. Small and constantly active, they need a continuous supply of food if they are to survive. The shrews maintain their patrols even when conditions become less favourable, and many of them die in severe weather. Since they and other mammals are abroad, their predators–the stoats, weasels and owls–are on their rounds too.

Preparing for winter Among the mammals of the hedgerow is the hedgehog, which will be making its own arrangements for the coming months. Having selected a suitable site for its winter home, the hedgehog prepares the spot before retiring. Its nightly excursions become shorter and less frequent until it finally succumbs to sleep.

The squirrel, although perhaps less active for short spells, will be out and about during the autumn, preparing the many secret food stores which, in the winter, it will search out for sustenance.

Snails, which during the other months of the year have periodically sheltered in the hedge, now turn to it for a more permanent protection, as winter for them is a long inactive period. Sealing the mouth of their shell with a chalky plate (epiphragm), the snails find a resting place in the hedge bottom. Innumerable pupae of invertebrates, for example butterflies and moths, are suspended from the seemingly lifeless twigs, or hidden among the leaf litter at the base of the hedge.

Plants in autumn Between five and six hundred plant species have been recorded in hedgerows, but it is unlikely that more than half of these will be found regularly. If by the end of autumn the small plants have almost all died back to the ground, this is only a resting period. Beneath the soil seeds lie dormant, ready to spring to life when conditions are more favourable. Climbers, including bittersweet (woody nightshade), honeysuckle and white and black bryony, become conspicuous at this time of the year. Earlier they formed part of the dense jungle. But now their coloured fruits, containing seeds from which next year's plants will grow, advertise their presence by standing out against the withering vegetation.

Above: The hedgerow is spectacular on dew-laden October mornings when the webs of orb spiders glisten in the early light.

Below: Bank voles are among the commonest hedgerow animals. They are mainly vegetarian, but also live on insects, larvae and other small animals.

GRASSHOPPERS

Take a walk through a meadow in summer and you are bound to hear the chirpy, stridulating song made by the grasshopper. It is a surprisingly loud sound for such a small creature.

Grasshoppers belong to the insect order Orthoptera. Occasionally this order is divided into three groups – the short-horned grasshoppers, the long-horned grasshoppers and the crickets. But this classification is confusing because the long-horned grasshoppers are more closely related to the crickets, both having long, thread-like antennae and certain other features in common. It is now customary to call the three groups respectively grasshoppers, bush crickets and crickets. Here we describe grasshoppers, which have short, thick antennae.

In common with most other Orthoptera, the grasshoppers have two distinct characteristics: they jump and they sing. Jumping is achieved by the long powerful hind legs which are normally held in a sharply angled position and can be straightened suddenly so as to hurl the insect forward to a height and distance many times its own length; the grasshopper's small size saves it from being injured when it falls to earth again. As in most insects that have 'voices', singing is performed by stridulation – the scraping of a hard ridge on one part of the body over a series of closely set pegs or teeth on another part. Stroking your nail along a comb illustrates this very well.

Grasshoppers have fairly large eyes, short antennae, and hearing organs on each side of the base of the abdomen. Each 'ear' consists of a pressure-sensitive stretched membrane, called the tympanum, lying in a small pit.

Life in the grass Grasshoppers are well named for they all live among grass, and grass is their principal food. They lay their eggs enclosed in little packets called egg-pods, each one consisting of a fairly tough case and containing up to 14 eggs. Grasshoppers overwinter as eggs, and the pods serve to protect them during this long period. Some species insert the pods a little way into the ground, while others place them at the base of tufts of grass.

Hatching usually takes place in April.

Above: Meadow grasshoppers (*Chorthippus parallelus*) mating. The males are usually smaller than the females, which are about 2cm ($\frac{3}{4}$in) in length. Like all British grasshoppers, this species feeds on grass and is active in daylight; but unlike other species, it has vestigial wings and cannot fly. This species is widespread throughout the British Isles, with the exception of Ireland, the Isle of Man and some Scottish islands.

Grasshopper anatomy Male and female grasshoppers can be distinguished by the shape of their abdomen tips (below). The male has a turned-up tip while the female's is straighter. The front pair of wings is thicker than the back.

male

female

The young grasshopper, or nymph, is at first enclosed in a membraneous sac so that it looks like a small worm or grub. After wriggling out of the egg this worm-shaped (vermiform) larva sheds its skin and assumes the form of a minute wingless grasshopper. The nymph sheds its skin four more times before becoming an adult with fully developed wings.

Common grasshoppers There are only 11 species of grasshopper native to Britain, but they are not easy to distinguish. In all of them the coloration is more or less variable and is not a reliable guide to the species. They are therefore separated by reference to details in the form of the wings, thorax and antennae, and the number and spacing of the stridulatory pegs on the hind legs. If you have a good musical ear, the grasshopper's song is often the best clue to its identity. Females are usually a little larger than males.

The common green grasshopper is usually green above, with brown or purple sides, but there is also an all-brown variety of the male. The wings are well-developed and the males fly readily. The male has 100 to 140 stridulatory pegs on each hind leg.

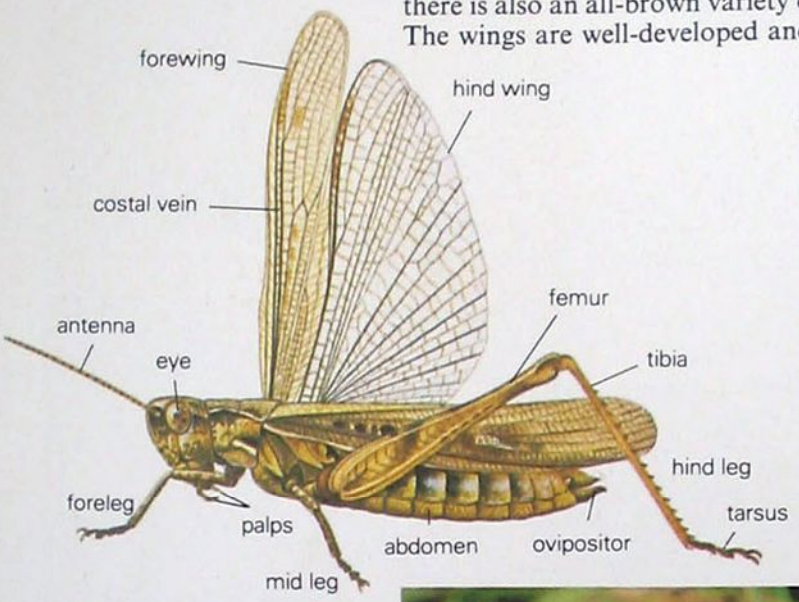
This grasshopper lives in grassland where the vegetation is fairly thick and lush. The green variety of the male is commoner than the brown in moister, greener surroundings. It occurs all over the British Isles; in southern England nymphs first appear in April or May, rarely earlier. Adults are usually plentiful from July to September, when they begin to die off.

The normal song of the male is a prolonged and rapid ticking sound, each burst of song lasting 10 to 20 seconds or longer. In the presence of the female a much less regular song is produced.

The common field grasshopper is variable in colour, ranging from green and brown, pink and purple, to almost black, but the body is never wholly green above. The wings are well-developed, making it the best flyer of all our grasshoppers. It is also one of the largest. The male stridulatory organ consists of 50 to 90 pegs.

This is another common species, which prefers dry situations with exposed rock (or concrete) and is often seen on roadsides and among buildings. It is found all over the British Isles but is uncommon in the far north. The male sings in a series of six to ten short brisk chirps, each chirp lasting rather less than half a second. Two or more males together often chirp alternately at a higher tempo than that of a solitary male. There is no special courtship song, but the unmated females sing freely though less loudly than the males.

In the meadow grasshopper the wings are much reduced, the hind wings being vestigial in both sexes. The forewings of the female are shortened while those of the male barely reach the tip of the abdomen. Neither sex is



Right: A common green grasshopper (*Omocestus viridulus*); this is a female (you can tell by the shape of the tip of the abdomen). Females reach a length of 2cm (about $\frac{3}{4}$in). This is the only species that is common in high moorland areas as well as most lowland grassy habitats.

capable of sustained flight. Green, brown and purple varieties occur, and the male has 70 to 130 stridulatory pegs.

The meadow grasshopper is a little smaller than the common green. It is found in all kinds of grasslands throughout Great Britain, but does not extend to Ireland, where its absence may well be due to its inability to fly. Ireland was separated from Europe long before the English Channel was formed. Insects migrating north after the last Ice Age could easily reach England, but those that were unable to fly would not have been able to reach Ireland.

The male song is rather subdued and consists of little bursts of stridulation, each lasting from one to three seconds and spaced at three to fifteen-second intervals. The singing is a little more animated in the presence of a female.

Rarities The three species already described are common and widespread, but the stripe-winged grasshopper is confined to southern England. It is mainly green but varies considerably, often appearing distinctly striped when seen from above. The wings are well-developed and the male has 300 to 450 small stridulatory pegs. The song is distinctive, consisting of a continuous wheezy sound which lasts for about 10 to 20 seconds and is repeated at irregular intervals. In courtship the grasshopper alternates this sound with a subdued ticking.

Our largest and most exciting species is the large marsh grasshopper. It is distinguished by the colour of the hind legs: red on the inner surface of the femur, or on the thick basal half, and black and yellow towards the tip. Otherwise it is variously coloured dull green or brown. There are no stridulatory pegs on the legs of either sex. The male chirps by flicking the ends of his hind legs on to the tips of the wings, usually using one leg at a time. This is a rare insect, which is confined to wet bogs. Its occurrence in the British Isles is curious–a patchy distribution in southern England and the westernmost parts of Ireland. In particular it frequents areas where bog myrtle and bog asphodel grow. In England there is a colony in the New Forest.

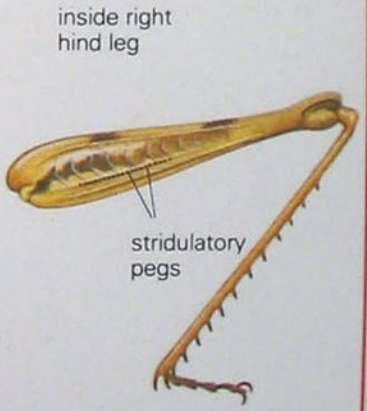
Above: One of our rarer species of grasshopper, the stripe-winged (*Stenobothrus lineatus*); this species can be found in southern England on dry, chalky soils where the grass is fairly short.

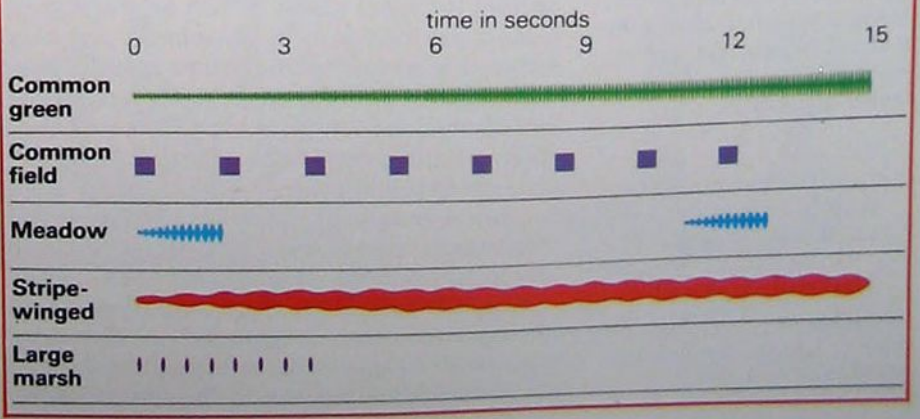
Right: The large marsh grasshopper (*Stethophyma grossum*), our largest and rarest species. Females may measure up to 3.2cm ($1\frac{1}{4}$in). You'll find them only in wet bogs and fens; there is a well-known colony in the New Forest.

The grasshopper's song

If you watch a singing grasshopper, you'll see it making small movements with its legs. On the inner surface of the large thigh-joint there is a row of minute teeth or pegs which are pressed against the more prominent veins of the forewing on each side. The leg movements cause the wings to vibrate and produce the characteristic stridulating sound. This equipment is well-developed only in the males. Each species of male grasshopper has a specific song by which it can be recognised. Differences in 'voices' are determined by the number and spacing of the pegs.

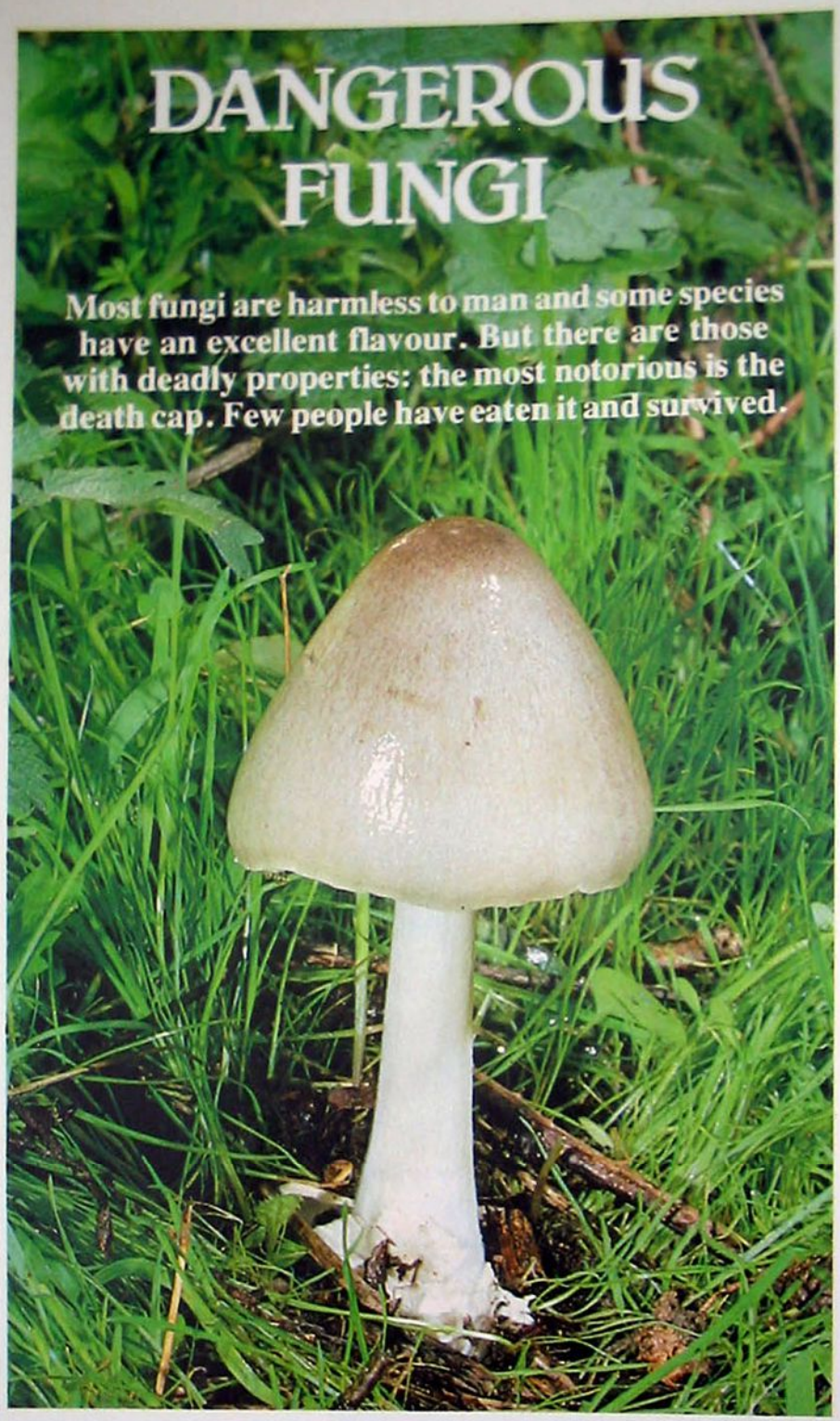
Each song has been represented diagrammatically (below) by a horizontal pattern drawn parallel to a time scale in seconds. Each coloured mark denotes a sound; the spaces between each, silence. The width of each mark gives an indication of the loudness of the song.





DANGEROUS FUNGI

Most fungi are harmless to man and some species have an excellent flavour. But there are those with deadly properties: the most notorious is the death cap. Few people have eaten it and survived.



Death cap (*Amanita phalloides*) appears summer-autumn on woodland floors, particularly beech. May also be found in pastures and on lawns.
Deadly poisonous.

Mushrooms and toadstools have long been regarded with suspicion. Yet of the 6000 species recorded in the British Isles less than a score are known to be poisonous, and only a few of these have proved to be lethal. There are some delicious species which few people would even contemplate eating because they look so different from edible mushrooms sold in shops. Perhaps this is just as well, because some ghastly mistakes have occurred. No fungus should be eaten unless you are absolutely positive about its identification.

The infamous death cap, fairly common in the British Isles, is regarded as the most poisonous fungus in the world; all parts of it, even the spores, are toxic. The cap is usually an olive-green colour, but it can vary from a pale greenish-yellow to light tan. When it first appears it is rounded or egg-shaped, but it later opens out to become almost flat and up to 10cm (4in) across. A ring hangs loosely under the cap like a frill, partially covering the white stem which is 5-10cm (2-4in) tall. The gills are white or creamish in colour.

Even just a quarter of a death cap can be fatal to humans. One of its most distinguished victims was Pope Clement VII in 1534. Together with its close relatives, the destroying angel and fool's mushroom, the death cap accounts for over 90% of all fatal fungi poisonings.

The death cap acts in a particularly insidious way because the first symptoms are not felt until 6-15 hours after it has been eaten, by which time the toxin has been absorbed into the blood stream and circulated throughout the body. At this stage conventional treatment with a stomach pump is useless.

The poison progressively damages the liver and kidneys as the victim suffers an agonising pain and stomach upset. After two days or so these symptoms may suddenly disappear, only to return a few hours later much more violently. As the nervous system becomes gradually paralysed the patient lapses into a coma, taking up to ten days to die.

Destroying angel, very similar to the death cap, contains equally lethal slow-acting poison and is said to have killed Emperor Claudius of Rome. Fortunately it is rarely found in the British Isles, although it grows occasionally in broadleaved woodland. It has a white, rather sticky conical cap about 10cm (4in) across, and white gills, and is supported on a slender white stem up to 15cm (6in) long, which tends to be covered in flaky scales.

The fly agaric is so well-known that it hardly needs description. It is a beautiful species, and a firm favourite of illustrators of fairy tales. However it is poisonous, although not dangerously so unless taken in large quantities. In 1893 an Italian diplomat in the United States ate two dozen fly agarics for breakfast, and died the following day after a prolonged bout of violent convulsions. The species gets its name from its former household use against flies. The caps used to be mashed with milk and sugar and the mixture laid out as bait to attract and kill flies.

The fly agaric is a woodland species that appears in autumn, often in large groups and sometimes in rings. Typically it is found under birch trees with whose roots it forms a mutually beneficial relationship involving the exchange of nutrients. But it is also common in coniferous woods and plantations.

When young the cap is round and covered with a soft creamy white membrane or veil. As the fruiting body grows it pushes through the veil, patches of which are left sticking to the bright scarlet cap. As the cap expands and flattens out, the white spots form an evenly spaced pattern, although they are often

washed off by rain. The gills and stem are white. It grows up to 20cm (8in) and the stem gently tapers from a swollen base.

Fly agaric contains small amounts of muscarine–a nerve poison–but the major toxins are ibotenic acid and muscimol, which cause headache, tiredness, nausea and intoxication. This latter property has been exploited for centuries by a wide variety of peoples. Several tribes in Siberia, notably the Koryaks, used to eat fly agarics in dried form to induce hallucinations and delirium. Recently, however, this practice has been more or less replaced by vodka drinking.

The panther is similar to the fly agaric but differs in that the cap is a smoky-brown colour. It is rather rare in the British Isles, appearing under deciduous woodland, especially beech. It contains muscarine in much higher concentrations than the fly agaric, and has been responsible for a number of deaths in Europe where it is more common.

The yellow-stainer often causes a violent stomach upset, although some people are immune, and is not fatal–with recovery in a few days. In some years it springs up in abundance and is often mistaken for the edible field mushroom. The cap is white when young, turning greyish towards the centre as it expands to about 10cm (4in) across. The gills mature from pale cream to a chocolate brown colour. To identify the species, cut the base of the stem; if it turns bright yellow instantly, then leave it alone.

The Inocybe species are a large group of fungi, some of which are poisonous. The red-staining inocybe is another species that has often been confused with the field mushroom, with tragic consequences, since its flesh contains a high concentration of muscarine. It appears rather infrequently along grassy paths, in woodland glades and in the shade of beech trees. The cap is up to 8cm (3in) across, whitish or pale brown at first, gradually staining red where the cap splits with age. The stem is fibrous and rather tough. It is white or creamy brown in colour, but if bruised during handling soon becomes spotted with red patches. The common white inocybe is a widespread poisonous species.

Should you eat it?
No fungus should be eaten unless you are absolutely positive about its identification. Never rely on the old belief that only edible species have a cap from which the skin can be peeled: the death cap peels easily, yet it is deadly poisonous.
Collect whole specimens that look fresh, and never think of eating anything until it is mature enough for the gills and spore colour to be visible. If you are really sure you have an edible species, cook it first. Some fungi can add a delicious flavour to soups and stews.

Red-staining inocybe (*Inocybe patouillardii*) appears summer-autumn by woods, in grass. Poisonous.

Fly agaric (*Amanita muscaria*) appears in autumn, often round birch trees or in coniferous woodland. Poisonous.

Destroying angel (*Amanita virosa*) appears in autumn in mixed woodland. Rare. Poisonous.

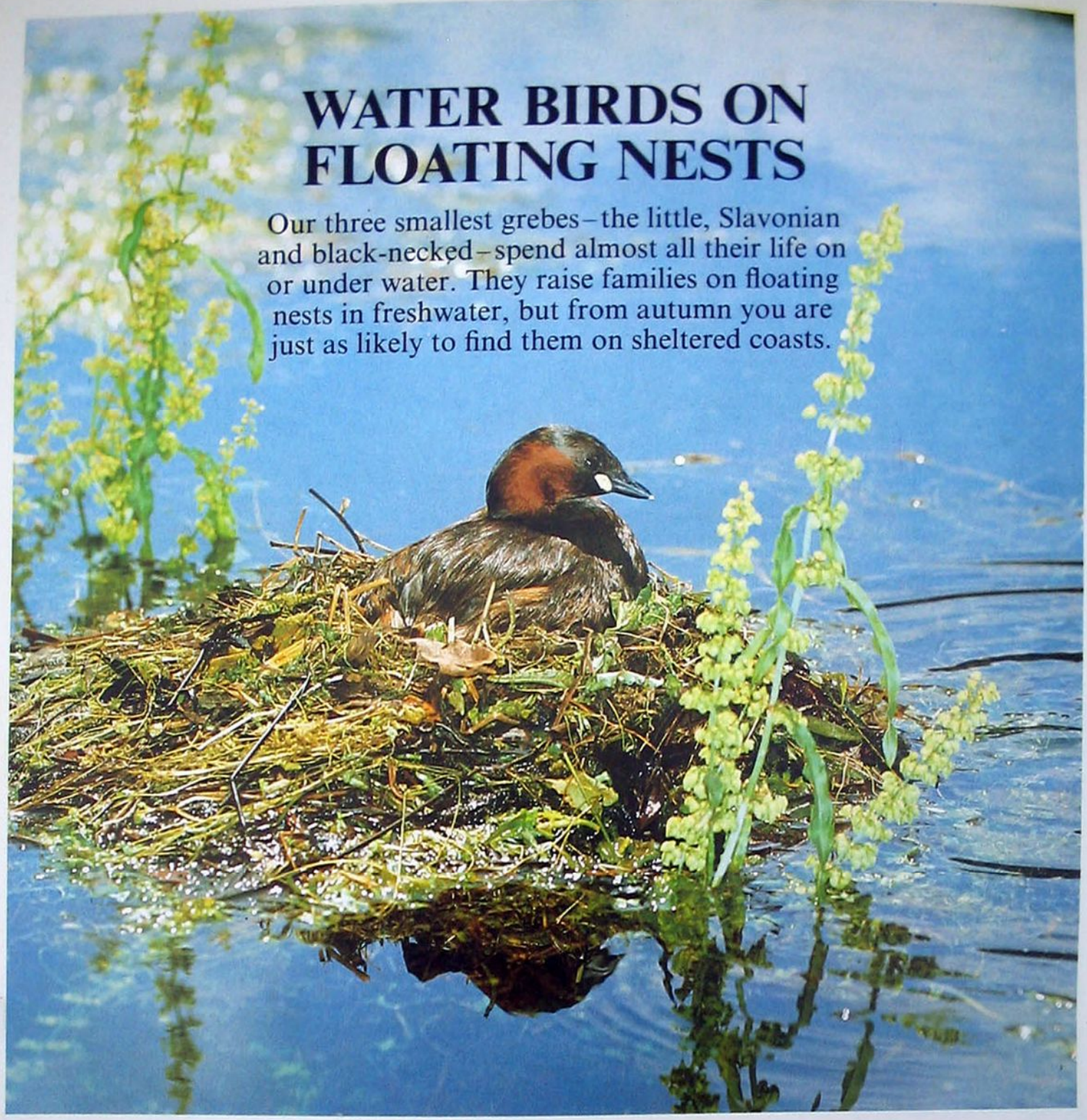
The panther (*Amanita pantherina*) appears in autumn in deciduous woodland. Rare. Poisonous.

Common white inocybe (*Inocybe geophylla*) appears in autumn in mixed woodland. Common. Poisonous.

Yellow-staining mushroom (*Agaricus xanthodermus*) common in fields, parks. Not deadly, causes discomfort.

WATER BIRDS ON FLOATING NESTS

Our three smallest grebes – the little, Slavonian and black-necked – spend almost all their life on or under water. They raise families on floating nests in freshwater, but from autumn you are just as likely to find them on sheltered coasts.



There are four species of grebe that breed in Britain. The largest of these, the great-crested grebe, will be dealt with in a future article. The other three species – the little grebe (or dabchick), Slavonian grebe and black-necked grebe – are all small, about half the length of the average duck. Although ducks tend to be more common on ponds, lakes and reservoirs, if you look carefully you may spot a grebe in such a habitat – perhaps in deep water but often near reed-fringed edges.

Grebes are not difficult to pick out because of their characteristic shape – a noticeable, rounded hump of a body without any tail feathers (by contrast, the duck's tail usually sticks up at an angle). The grebe's neck is longer than the duck's in proportion to the body, and grebes have a pointed bill quite unlike that of ducks.

Paddle-power Grebes may swim very low in the water, especially if alarmed, and when feeding they frequently dive. Like most swimming birds they paddle with their feet both on top of, and under, the water. Instead of having webbed feet like ducks and gulls, the long toes of all grebes have flaps of skin or lobes to make them into broad, efficient paddles. (The only other common bird with feet like this is the coot.) Grebes' wings are curved and lie closely against the streamlined body to ensure maximum speed.

Above: The male and female little grebe share the duty of incubating the eggs on their floating nest. The nest, consisting of a pile of waterweed loosely anchored to surrounding aquatic vegetation, is about 30cm (1ft) in diameter.

Little grebe (*Tachybaptus ruficollis*), 27cm (10½in) from beak to tip of tail. Sexes alike. Distribution most widespread of all grebes; partial migrant.

The little grebe, or dabchick, is the smallest European grebe and by far the most common. It is found throughout the whole of Britain but seems to prefer still lakes with dense vegetation at the edges. It also frequents small ponds, lochs and slow-moving streams. In the breeding season the little grebe stays hidden among the reeds (and is very difficult to spot), but in autumn and winter you may discover small flocks out in open water.

Dabchicks look very dumpy and blunt-ended at the back when they fluff out their feathers. In the summer, adults have blackish and dark brown body feathers, a black head and neck with chestnut cheeks and throat and, at the base of each side of the bill, a conspicuous pale yellow patch. (As with the other two grebe species, the plumage changes in winter.)

Dabchicks' head feathers are not as striking as other grebes' and their courtship displays are less dramatic, but you should listen for the distinctive call. Both sexes make a loud, drawn-out, whinnying trill, sometimes rising and falling in pitch. Occasionally they perform a duet.

Slavonian and black-necked grebes are very similar to each other (see illustration) but, as you might expect, the latter species has a black neck (though only in summer); the Slavonian's neck is chestnut. They also differ in the size and the positioning of their bright yellow 'ear tufts'–those of the Slavonian grebe sweep back from the eyes like horns (in America it is called the horned grebe), while those of the black-necked grebe radiate like tiny fans. The eyes of these small grebes are bright red, unlike the dabchick's which are black.

Winter plumage After breeding, the adults moult. They replace their body feathers just a few at a time, so the change to winter plumage is slow. However, all the flight feathers on the wings drop out together so the grebes are flightless for up to a month while new feathers grow.

Most land birds need to retain the ability to fly so that they can escape from predators, but grebes rely on the safety of water and thick waterside vegetation to hide in. They even sleep on the water.

In their winter plumage little grebes are generally brown and white, and therefore fairly easily distinguished from the other species which are black, grey and white. If you see one of the three small grebe species flying–they all fly with neck outstretched and legs dangling behind–only black-necked and Slavonian grebes have white on the wings. In winter, the black-necked grebe has a dusky neck and the black of the crown extends below eye level. Its bill is also slightly uptilted. In

Above: As with other grebes the little grebe's feet are positioned right at the back of the body (in the same way that boats have propellers at the stern) to provide good forward propulsion. However, this also means they are very clumsy on land and therefore rarely leave the water.

Below: The Slavonian and the black-necked grebe illustrated here, are both adults in their breeding plumage. Note the young chicks carried by the black-necked grebe.

Weed-rush ceremony of Slavonian grebes

Grebes are well known for their amazing courtship displays, when they raise and fan their head feathers – showing off the colours to prospective mates. Complex rituals are performed in strict sequence. Perhaps the most dramatic display is the weed-rush ceremony exhibited by the Slavonian grebes.
Both male and female Slavonian grebe dive and then surface with some soft weed dangling from their bills. The courting pair approach one another and rise up breast to breast in a sort of dance (right). Then, in the same upright, penguin-like posture, they turn and dash across the water side by side for several metres; this can be repeated up to ten times.

Slavonian grebe (*Podiceps auritus*), 33cm (13in) from beak to tip of tail. Sexes alike. Rare, partial migrant.

Below: On the central depression of her floating nest, the female little grebe lays 4-6 whitish eggs. The parents start incubation before the clutch is complete and, as a chick can swim within a few hours of hatching, it is not uncommon to see the mother feeding one while brooding the still unhatched eggs.

contrast, the Slavonian grebe has a whitish neck and the black crown stops abruptly at eye level. It has a flatter forehead than the black-necked grebe, and a straight bill.

Floating nest Grebes make floating nests – a remarkable adaptation to a totally aquatic life. Little grebes often start several nests before choosing the best one to complete. The clutch of 4-6 eggs may be only 4cm ($1\frac{1}{2}$in) above the water. Passing boats are a dangerous threat because the waves they create can easily wash the eggs off the nesting platform. The eggs are initially chalky white, but they soon become stained brown by the rotting nest material.

The chicks hatch after about three weeks and are already covered in fluffy black and white down. They can swim within a few hours and dive after about ten days, but usually stay in the nest for the first week or so. They are often of slightly varying sizes because they hatch on different days – the first eggs to be laid hatch first because the parents start incubation before the clutch is complete.

Chicks hitch a ride The parents also have the fascinating habit of encouraging the brood to take rides. The chicks, while small, are particularly vulnerable to predatory fish such as pike, and they soon learn to climb onto the back of one of their parents and hide among the feathers while the other parent dives to catch food for them. Often all that can be seen is a tiny striped head poking up between the wings. It is a month or even longer before the chicks are fully independent.

Grebes' diet Small grebes rarely go more than 2m (6ft) down when they dive in search of food, although Slavonian grebes have been known to dive down to 25m (80ft). Grebes take insects and larvae, molluscs, tadpoles, small fish and crustaceans. They eat the smaller prey while submerged. Although dives usually only last 10 to 25 seconds, actively feeding birds spend more time under the water than above.

Sometimes they take food from the surface or swim with just their head below the water, and occasionally you may see one catching flying insects when they come within reach.

Secret sites Slavonian and black-necked grebes first nested in Britain early in this century. By 1930 there were hundreds of breeding black-necked grebes in a single colony in Ireland, but today both species are very rare. The breeding sites are usually shallow freshwater lochs in Scotland, but the exact locations are kept secret.

In winter, however, the British population is joined by continental birds which, like ours, fly from their summer territories to spend the winter in warmer waters. Sheltered bays, estuaries and reservoirs are favourite spots. Little grebes tend to remain in the same territories all the year round unless they are forced out by bad weather.

Black-necked grebe (*Podiceps nigricollis*), 30cm (12in) from beak to tip of tail. Sexes alike. Rare, partial migrant.

Left: Although the adult little grebes take turns to incubate the eggs, one parent may leave the nest before the other is ready to return. In this case it carefully covers the eggs with weed to hide them from marauding crows.

RICH PICKINGS

The countryside in late summer offers a tasty array of edible fruits. Blackberries are very common, but there are a number of allied species that are just as succulent and worth the hard search.

The bramble (*Rubus fruticosus*) or blackberry is the most familiar member of the genus *Rubus*, which is represented in the British Isles by five main species. At the same time it is one of the most puzzling of our shrub groups. It is so variable that, at the last count, over 400 variants, variously called subspecies, varieties, forms and cultivars, had been described. More are added each year by batologists who study variations in brambles. Brambles vary considerably in form, shape and colour of the leaves and flowers, and in the flavour of the fruit.

Brambles grow in a wide range of habitats and on most types of soil, but they achieve their finest growth sprawling along straggling hedgerows, using other bushes for support. A tangled hedge smothered by brambles provides a rich harvest when the blackberrying season arrives in late summer.

Farmers used to plant brambles in quickset (hawthorn) hedges to bind them together and produce a dense, prickly barrier to livestock. Traditionally, planting was confined to those months with an R in the name, but that only left from May to August when planting was considered unwise, so in effect farmers could plant at all times except high summer.

Prickly colonizers The long, tough stems of brambles are armed with hooked prickles. These not only deter grazing animals, and scratch the hands of blackberry pickers, but also help the stems catch on to the bushes over which they clamber. The stems arch over and sprout roots where they touch the ground. This is an extremely effective way of vegetative reproduction, allowing the plants to leap-frog over hedges or spread low along the ground. The bramble is an extremely aggressive colonizer; for example, it was introduced to New Zealand where it ran amok and is one of their most troublesome agricultural weeds.

In open ground, such as neglected pastures, commons and railway embankments, brambles tend to form dense thickets. They also grow in woodland, sprawling low over the forest floor. Woodland brambles produce few flowers because they are inhibited by the shade of trees.

Blackberries provide delicious fruits from August to early October. They are a rich reward on late summer walks, and when gathered in quantity they make superb jellies, jam, pies and even wine. They are one of the few species you can pick without feeling guilty; bushes growing in the open produce hundreds of berries every season.

Leaves and blossom Bramble leaves are compound, made up of three to five, sometimes seven, oval leaflets with sharply serrated margins. The stalk and central vein or midrib on the underside of each leaflet may also have tiny prickles. The flowers grow in loose clusters towards the tips of the stems and vary considerably in number, size and colour. The first blossoms appear in May or June. The compound fruits, the position of the ovaries and the numerous stamens makes them easily identifiable as belonging to the Rose family.

The five petals are usually a delicate shade of pink with a distinctive satin-like texture, and surround a dense crown of stamens. The flowers are pollinated by many insects, but often by bumble and honey bees which are attracted to the copious supply of nectar. In the absence of insect pollination brambles can still set good seed: self-pollination often occurs, and seed can even be formed without fertilisation of the ovary–a process known as apomixis. Such a varied reproductive system, and the fact that brambles readily hybridise, has resulted in a large number of varieties.

Berries The flowers are succeeded by berries which are green at first then change to dark red and black when they ripen in August and September. It is not unusual to find flowers and all the colour stages of berries on the same spray. The berries are composed of numerous drupelets, each enclosing a single seed, or pip, tightly packed on to the dome-shaped flower base.

All our native *Rubus* species produce edible fruits. The wild raspberry is the origin of all garden varieties and has been in cultivation

Above: A bramble bush with a good crop of ripening blackberries.

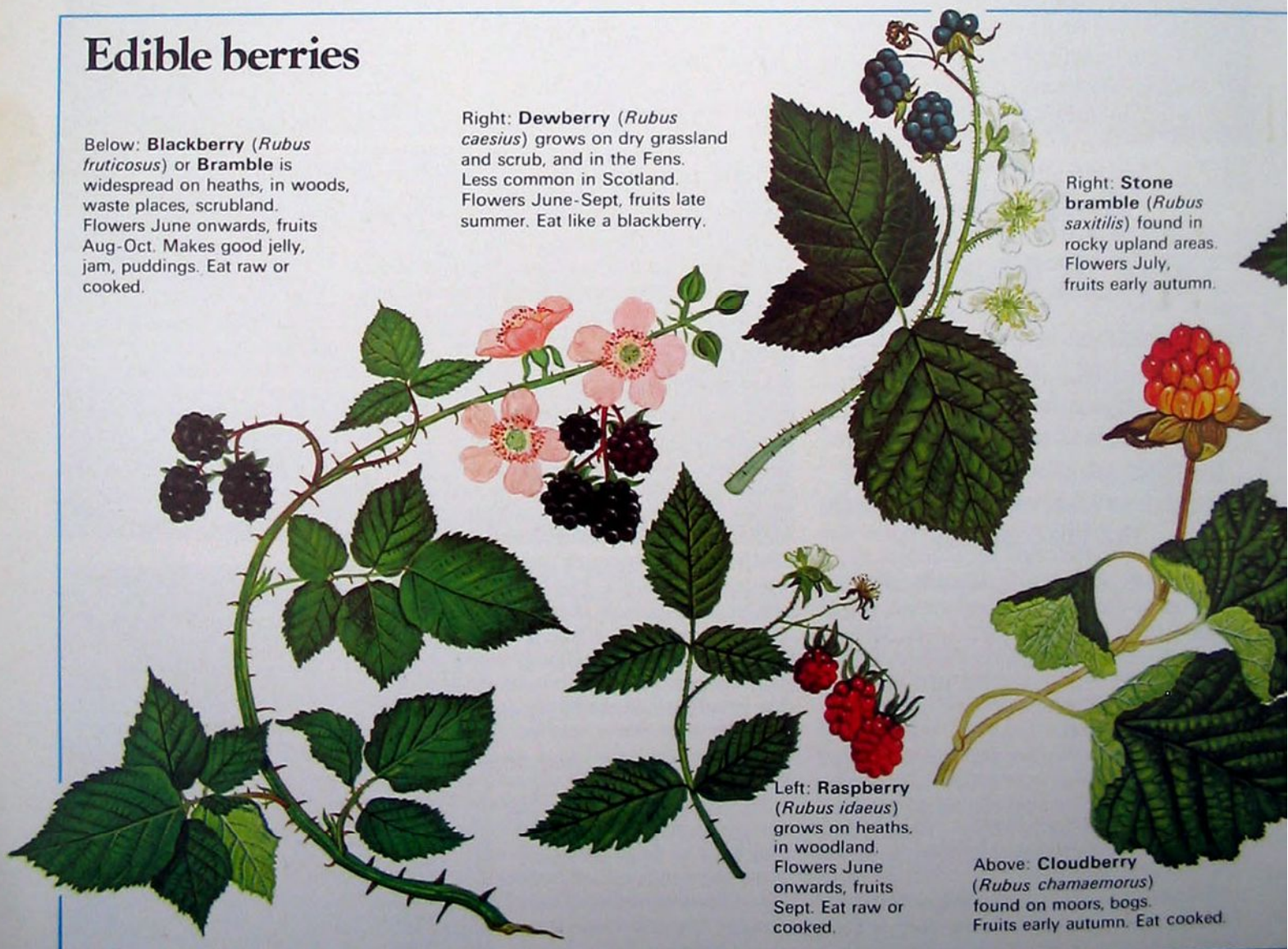
Right: The hedge brown butterfly is invariably associated with brambles. The adults feed exclusively on bramble blossom.

Edible berries

Below: **Blackberry** (*Rubus fruticosus*) or **Bramble** is widespread on heaths, in woods, waste places, scrubland. Flowers June onwards, fruits Aug-Oct. Makes good jelly, jam, puddings. Eat raw or cooked.

Right: **Dewberry** (*Rubus caesius*) grows on dry grassland and scrub, and in the Fens. Less common in Scotland. Flowers June-Sept, fruits late summer. Eat like a blackberry.

Right: **Stone bramble** (*Rubus saxitilis*) found in rocky upland areas. Flowers July, fruits early autumn.



Left: **Raspberry** (*Rubus idaeus*) grows on heaths, in woodland. Flowers June onwards, fruits Sept. Eat raw or cooked.

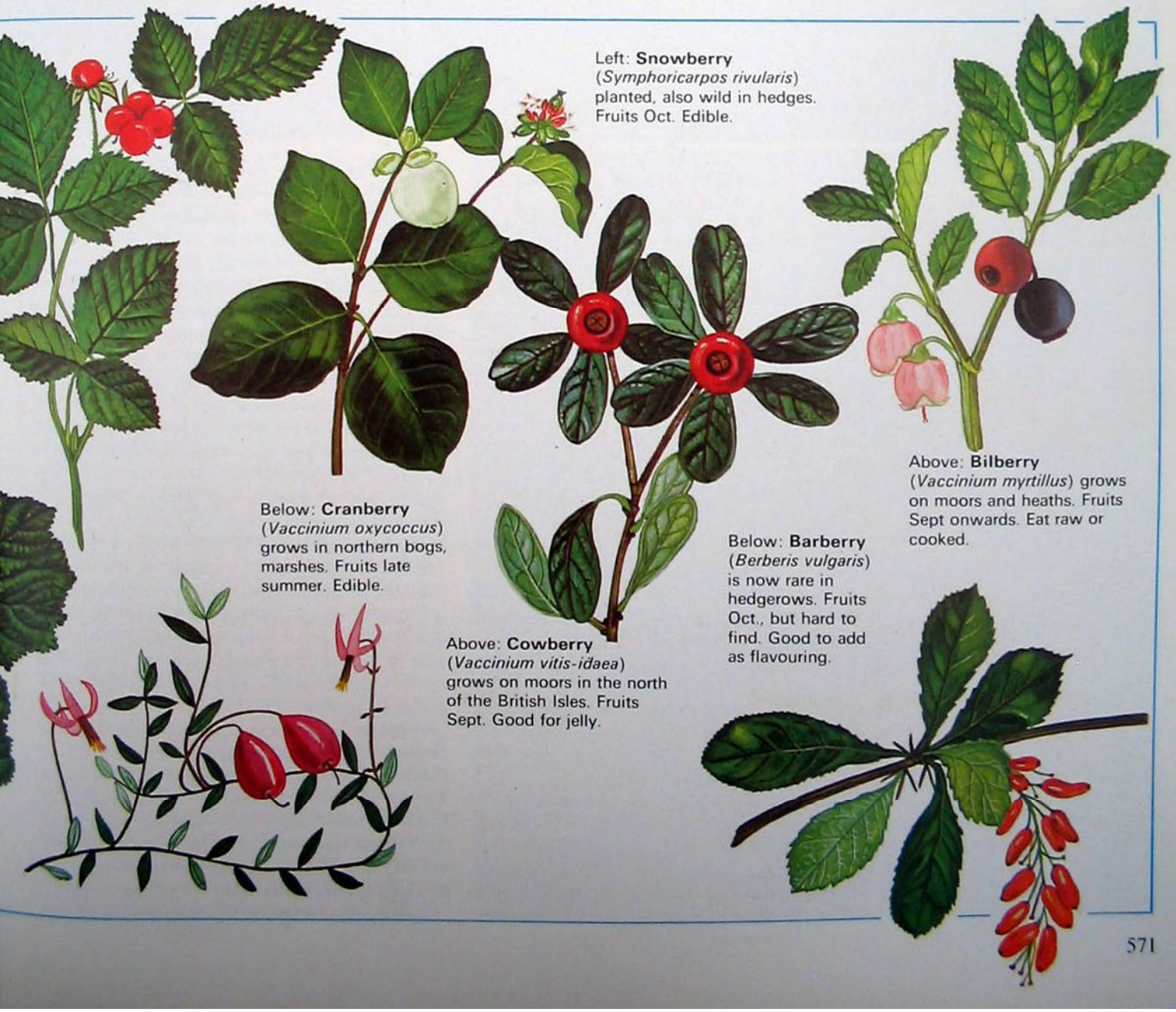
Above: **Cloudberry** (*Rubus chamaemorus*) found on moors, bogs. Fruits early autumn. Eat cooked.

for centuries. The fruit is soft, red and juicy and, unlike the blackberry, is easily pulled from its cone-shaped receptacle.

The dewberry, which always has pure white blossom, has a fruit consisting of a few large, black, succulent drupelets covered with a dusty, greyish bloom. The stone bramble produces a crimson berry which has an excellent flavour. Cloudberries are a rich orange colour when ripe, and are much larger than blackberries. They have a pleasantly sharp taste.

The seeds of *Rubus* species rely on birds for their dispersal: the juicy fruits act as a bribe to birds for the favour of carrying away the pips and depositing them elsewhere. Many mammals, too, apart from man, are fond of the berries, although they disperse the seeds over a more limited area than birds.

Autumn brambles The colours of bramble leaves in autumn are beautifully varied in tone, ranging from rich orange to crimson, russet-brown, and even purple–often all combined to form a colourful mottled mosaic on each leaf. Not all the leaves change colour, however, and some remain dark green throughout winter.


Left: **Snowberry** (*Symphoricarpos rivularis*) planted, also wild in hedges. Fruits Oct. Edible.
Above: **Bilberry** (*Vaccinium myrtillus*) grows on moors and heaths. Fruits Sept onwards. Eat raw or cooked.
Below: **Cranberry** (*Vaccinium oxycoccus*) grows in northern bogs, marshes. Fruits late summer. Edible.
Above: **Cowberry** (*Vaccinium vitis-idaea*) grows on moors in the north of the British Isles. Fruits Sept. Good for jelly.
Below: **Barberry** (*Berberis vulgaris*) is now rare in hedgerows. Fruits Oct., but hard to find. Good to add as flavouring.

THE FRENZIED RUT OF THE RED DEER

For three weeks every autumn, the graceful red deer stag changes almost beyond recognition. One day he will be grazing peacefully with his fellow stags, the next he has become a roaring, restless beast, antlers at the ready to defend his harem of hinds.

RED DEER
(*Cervus elaphus*)
Size Max height at shoulder: male 122cm (48in), female 114cm (45in). Av weight: male 85kg (187lb), female 58kg (128lb), variable.
Breeding season Young born mainly late May and June.
No of young (calf) 1.
Lifespan Max 20 years.
Food Mainly grasses, sedges, rushes. Also heather, tree leaves, bark, herbs, lichens, ferns, mushrooms.
Predators Man. Young foxes and eagles.

Red deer, indigenous to Britain, are our largest land mammal. They were at one time much more widespread, inhabiting the woodland that covered much of the country. Today, British red deer can be divided into two groups: those that still exist in scattered herds in English woodland, and those that now live on mountains and moorland, notably in the Scottish Highlands, but also in Martindale in northern England.

Antlers Only the stags have antlers, which are generally lighter and shorter on Highland deer than those of southern, woodland deer, and with fewer points (tines). This is due to their poorer, harsher habitat. Average Highland stags have six to eight points on each antler. Some may have 10 or 12 points and, exceptionally, up to 16–or none at all. Woodland stags average 10 to 12 points, and may have as many as 20.

The number of points is no guide to the age of a stag. But a mature stag has thicker, longer, and often darker, antlers than a young stag with a similar number of points.

Changing coats Red deer grow new coats twice a year. The winter coat consists of two layers: an undercoat of soft, blue-grey, close-knit fur and an overcoat of long, crinkly hair which varies from very dark, blackish-brown, through red-brown to sandy yellow. This warm double coat is replaced in June by a thin single coat of glossy red hair.

Peaceful prelude The long days of summer are spent peacefully grazing on the higher mountain slopes, the sexes segregated into groups. Stags of three years and above move about quite separately from the hinds, who also keep in single-sex groups. The few antlered animals still with the hinds are young males (staggies).

Autumn aggression Towards the end of September the stag groups begin to grow restless. Their antlers are now hardened and darker in colour, from off-white to nearly black in some cases. The mature stags have grown tremendously shaggy, leonine manes, which make them look front-heavy in contrast to their heavily muscled but slim haunches.

After a day or two of voicing their unrest in

Left: If a stag slips and falls during combat, his opponent will do his best to gore him. The brow points of the antlers (those points that jut out just above the forehead) are used for this purpose. Fights to the death are rare, however. Usually one stag senses defeat and retreats.

Below: Except during the rut, red deer live mainly in single-sex societies. Young males (staggies) stay with the female group until the age of three years, when they break away to join a stag group.

preliminary roaring, some of the stags break away to roam through the hills in search of hinds. Once a stag has found a hind group, he expels every male in the group except the male calves of that year, and endeavours to hold the hinds for the three weeks' duration of the main rut–or until his strength fails.

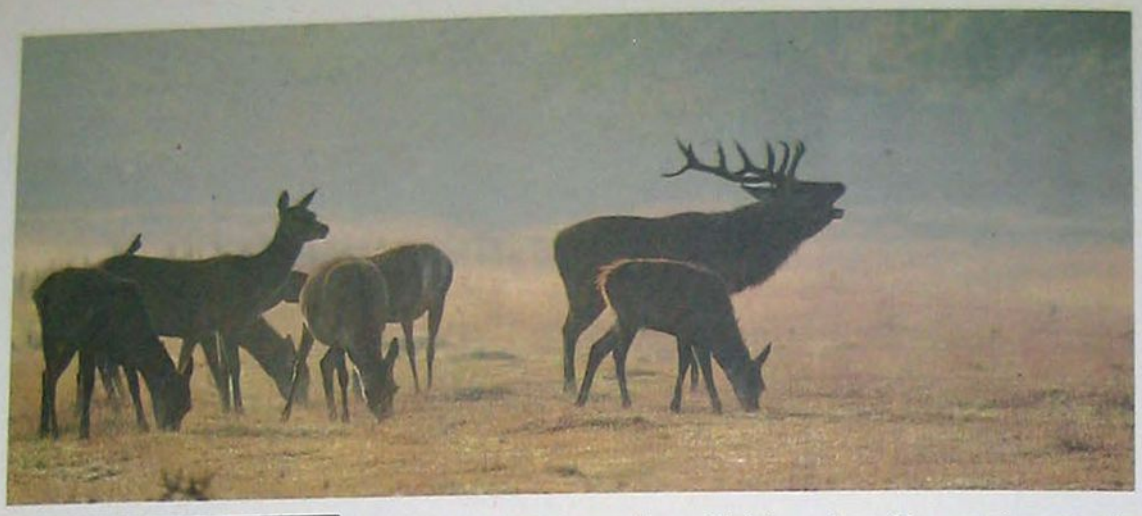
He becomes an animal possessed, and his demeanour alters dramatically. His gait changes from a graceful stride to a stiff-legged, stilted, menacing strut. His expression alters from one of almost bovine placidity to one of sullen aggression. His mane, already shaggy and thick at the onset of the rut, appears even thicker as a result of his wallowing in peat or mud–the individual hairs standing out stiff and spiky. His beautiful coat of summer red is similarly daubed and darkened. The hairs curling along the middle of his belly become wet, black and smelly with continual urinating. This, together with his habit of rolling in vegetation liberally sprayed with urine, give him the pungent, rank odour that is characteristic of the rutting stag.

Roaring incessantly, always on the alert to the incursion of any male, he is kept at fever pitch by the roaring of other stags nearby. Stags still searching for hinds, evicted staggies hanging around the group and hinds attempting to sneak away, all contribute to his continual state of unrest. He can neither sleep soundly nor eat properly, and it is hardly surprising that he loses weight and strength. It is an exceptional stag who can last the three weeks of the rut without being deposed by a fresher stag.

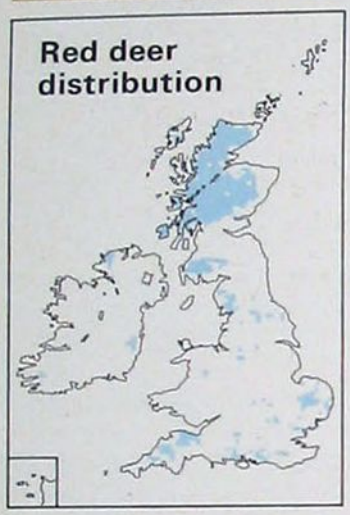
Furious combat Some fighting takes place each rutting season, as aspiring stags venture to dispute ownership of hinds. Challenger and challenged first size each other up by pacing, stiff-legged, around the group of hinds. The defending stag always keeps a head in front of the challenger, and on the inner side of the paced circle. If the intruder decides he is overmatched, he will break off from this pacing and strut away to find an easier opponent. He may give vent to his anger and disappointment by viciously demolishing a patch of heather with scything antlers, then roaring loudly over this 'victory'.

If the preliminaries end in combat, however, the two pacing stags suddenly wheel towards each other, apparently simultaneously, bringing their antlers together with a reverberating clash. With heads and necks bowed and straining, there ensues a titanic struggle of balance and strength. Each stag tries to gain uphill ground advantage, in order to push his opponent backwards in one tremendous rush. There is an uncanny silence during all this violent action, broken only by the occasional clicking and clashing of antlers.

Quite as suddenly as the combat started, the stag sensing defeat breaks off and literally runs for his life. The victor, if incensed enough, may follow for a few metres, scything at the



Left: The stag roars incessantly during the rut and is continually incensed by the roaring of other stags within hearing distance. He mates with his hinds as they come into season; no more than one or two hinds in his group will be in season on any one day. The hind stays in season for about 24 hours.



defeated stag's haunches with his antlers. He roars in breathless triumph, then returns to his hinds–if he is lucky enough to find them still there.

Fights which last long or end in fatalities are exceptional. Most last only a few minutes. Superficial wounds, like torn ears or forehead skin are fairly common, with occasionally more serious wounds such as punctured eyeballs which, of course, mean permanent blindness in the affected eye. There can be few red deer haunts which do not have a one-eyed stag from time to time.

After the rut By the end of October most of the rutting is over, and stags and hinds go their separate ways for the winter and spring months. Stags tend to spend these inhospitable months on lower ground, closer to human habitation, where the grazing is better but the risk of discovery greater. This is mainly a consequence of their reduced vitality and physical condition after the rut. A mature stag may have lost 13kg (2st) during this time.

In really severe weather, the hinds also come further down the hillsides to find food and better shelter. There is generally sufficient grazing to see the deer through the winter, but by spring there is little left, and a period of scarcity follows until the growth of new vegetation. This is the most difficult time for deer, particularly in the Highlands, and only the strongest and fittest survive. Mortality is mainly among weaker calves and ageing adults whose teeth or constitution are no longer adequate.

By mid-March the stags begin to cast their antlers, looking donkey-like and bereft of all dignity without them. Their winter coats are now bleached and shaggy. April is perhaps the hardest month of all, the deer still having to subsist on the scant remains of last year's vegetation.

The new growth of vegetation begins in May. Then the deer can gradually desert the lower ground for the higher, safer slopes. By June their new year is fully under way, with new grazing, renewed strength, new coats, fast-growing antlers and young calves.

Calving The hind gives birth relatively easily. Once she has dropped her calf, she licks it assiduously, eating the opaque membrane that covers it. At first the wet, black, new-born calf lies still beneath these ministrations, but after about ten minutes it begins to struggle weakly. Within about 30 minutes it is standing on its feet, swaying precariously, sometimes falling, but always struggling up again.

On wavering and apparently unco-ordinated legs, it pursues a weaving, lurching course to find the hind's udder and take its first, vital drink. It suckles for about ten minutes, then collapses again and lies still beneath the mother's renewed licking and grooming.

Peat and mud wallows

Red deer take peat or mud baths (wallows) throughout the year. They wallow most frequently during the rut and on hot, summer days, but also in cold, frosty weather, sometimes breaking ice to bathe.
The animal first urinates into the wallow and stirs it up with its antlers (or, in the case of the hind, with a foreleg). It rolls over on one side in the smelly liquid, then makes another half-roll to coat the other side. Finally, the deer rubs its neck and head on the side of the wallow and emerges glistening but stinking.
Wallowing helps deer keep cool, soothes itching caused by warble fly grubs or moulting, and provides a protective armour of insect repellent. The dried-on coat may be black or varying shades of brown or red, depending on whether the wallow is of peat or mud.

Daytime concealment For the first ten days of the calf's life, it is left alone from dawn to dusk, usually under some kind of cover. This may be long heather, the shadow of a rock or thick clumps of rushes. Very occasionally calves are left in conspicuous places, such as on bare green slopes or equally bare expanses of black peat.

The mother returns to her calf in the evening to let it suckle. She remains with it all night, then leaves it once again to continue her own grazing. If the calf is discovered alone on the hill in the first two days of life, it remains absolutely motionless. Later on, it may rise and run.

During its first weeks, the calf may use a penetrating, high-pitched emergency call, to appeal to the hind for help when danger threatens. This call carries over long distances and can bring as many as seven hinds stampeding to the rescue, all with calves hidden in the same area.

The hind has fiercely maternal instincts, and is utterly selfless in protecting her calf against predators. She will kill both foxes and eagles, trampling them into the ground with her flailing front hooves.

The stag, on the other hand, is an utterly selfish individualist who would not even recognise his own offspring. When in his prime, he mates with perhaps 20 hinds in each season. The romantic concept of the family proud father stag is pure myth. In a mating system based on polygamy, this could not occur.

Equally mythical is the romantic idea of the stag as proud leader of the herd. Even during the rut, it is the hind who takes the lead in times of danger. Although the stag may appear outwardly dominant over the hinds, it is one of the senior hinds who leads off in flight, the stag invariably bringing up the rear.

Revenue from red deer It is estimated by researchers that over 255,000 red deer live in the Scottish Highlands today. In their virtually sterile mountainous habitat they do provide an important factor in the economy of the Highlands. Deer-stalking and the venison trade to hotels provide much-needed jobs for a number of people, and a revenue of over two million pounds is collected annually from these concerns. Deer conservation is therefore an important issue.

Above: Calves are generally born in early summer. They keep their cream-dappled coat until they are about three months old.

Below: Red deer can subsist in all but the severest weather conditions. They scrape through soft snow to vegetation beneath, using a flailing foreleg.

SEA-BORNE MARAUDER

The Portuguese man o' war is not a single animal like the jellyfish which it resembles, but is an animal colony, made up of four types of individual called polyps.

The Portuguese man o' war lives in warm open seas, but is sometimes washed up on the southern and western shores of the British Isles. This surface-dwelling coelenterate measures up to 33cm (13in) long by 13cm (5in) wide and its longest tentacles hang down 2½m (9ft) or more.

At no time in its life cycle does it depend on shallow water or attach itself to the sea bed – unlike its close relatives the seafirs, and its more distant ones, the jellyfish (see pages 452-3).

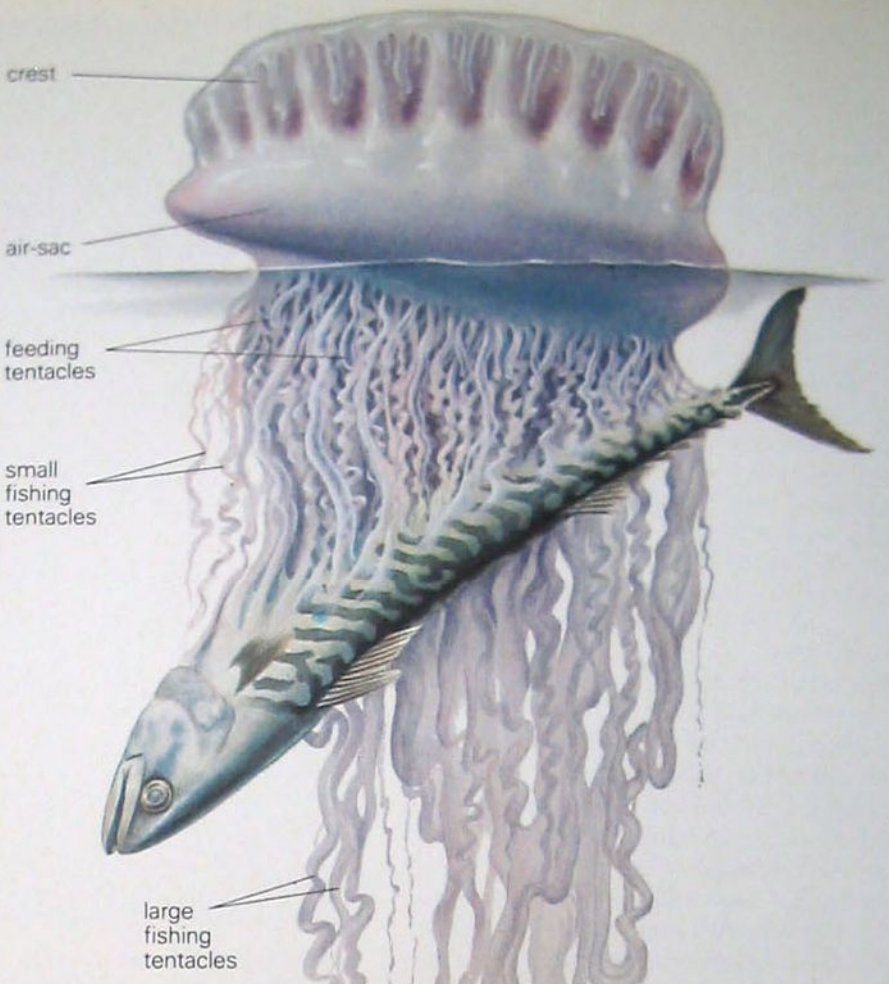
Four polyps Although superficially it resembles a jellyfish, the Portuguese man o' war differs in one important respect: it is an animal colony, not a solitary individual. The body is composed of a 'society' of four types of individuals called polyps.

The most conspicuous polyp is the single bag-like float called the air-sac. This gas-filled individual is the only part that can be seen above the water. At the top is a crest which catches the wind so the colony may be blown about.

Trailing traps Three other types of polyp hang from this float by short stalks. The long coiled tentacles containing powerful stinging cells, which make the Portuguese man o' war so dangerous, belong to the fishing and defensive polyps known as dactylozooids. They lack mouths and cannot feed; but they trail their long tentacles in the water like a drift net to trap and immobilise prey before transferring it to the mouths of the feeding polyps.

These feeding polyps, which hang in bunches, are called gastrozooids. They have a mouth with which to ingest prey, and a single tentacle to assist this. Their gastric cavities make connections with the other polyps in the colony and pass them food.

Reproduction The final type of polyp is the gonozooid. It produces medusae called gonophores which remain attached to the parent polyp. The gonophores produce eggs and sperm which are released into the sea and unite to form a larva. Still in the open water the larva develops and eventually founds another floating colony. At no stage in the animal's life cycle does the man o' war depend on the sea bed.



Like its distant jellyfish relatives, the Portuguese man o' war (*Physalia physalis*) moves at the mercy of wind and current. Though it lives in the open sea, it does occasionally get washed ashore if persistent winds blow from the south west. It can, however, regulate how much it is affected by the wind by deflating or inflating the air-sac. In rough weather it raises its tentacles and spreads them near the surface to increase stability. It also submerges the upper surface of the air-sac under water to stop the sun drying it.

The Portuguese man o' war relies on the strength of its stinging cells and tentacles to overwhelm prey such as surface-swimming fish, including young mackerel (above). Certain small fish such as *Stromateus* swim among the tentacles and appear resistant to the stinging cells. These fish, as well as some turtles, feed on this creature's tissues.

The name Portuguese man o' war may have been originated by early ocean navigators who were reminded of Portuguese war ships (caravels) by the animal's float polyp.

Left: If specimens are washed up on beaches, the float polyp is often broken off from the rest of the animal colony. Do *not* touch even a dead specimen because its stinging cells can still inflict severe wounds.

LIFE IN THE LAKES OF BRITAIN

Wastwater, seen in its rocky setting and whipped to a flurry by the wind, supports little life. Lakes vary in the life they contain: the key lies in the plant nutrients on which all lake life depends.

Lakes contain many varied habitats, with different features. This article describes some features that are common to all freshwater lakes in Britain. But because deeper lakes tend to have a more complex and interesting structure, we shall be concerned mainly with the deep lakes of upland Britain. Our definition of a lake is a large natural expanse of open water exposed to the full force of the wind – which means that waves break over its exposed shores. Normally the upland lakes are too deep, over most of their area, to permit light to penetrate and enable rooted plants to grow on the bottom.

Lake nutrients Every gardener knows that good crops can be grown only if his land is

Above: Surrounded by grazing land and forestry, Loch of the Lowes in lowland Scotland is a productive lake.

well-fertilised to provide nitrates, phosphorus, carbonates and other chemicals needed for plant growth. In a lake the plants need the same substances and, in addition to those already there, more are brought in by the waters entering the lake. It is not, however, the large plants that are important in the natural history of a lake but the immense quantities of microscopic plants that float freely in the upper water. These are the primary producers, and on them the food webs of the lake mainly depend.

Lakes in regions of hard (for example, volcanic) rocks, which provide few nutrients, receive poor supplies of these essential substances in the waters flowing into them, and are unproductive of plants and animals. The bottom of these lakes remains stony or rocky.

In areas where the rocks are softer, this often shows in the gentler contours of the country and the presence of good farming land. The drainage waters reaching the lakes are rich in dissolved substances, and also carry particles of soil and other undissolved matter which together are known as silt. The silt sinks to the bottom, and in time provides further nutrients. Such lakes are productive of plants and animals.

Examples of productive lakes are Esthwaite Water and Windermere in the Lake District. Ennerdale, Wastwater and Buttermere are typically unproductive lakes.

Windermere was not always as productive as it is now, and has changed comparatively recently. Scientists examining samples of mud from the bottom of the lake find that two single-celled plant species, *Asterionella* and *Fragilaria*, indicative of a productive lake, have been present in the lake for only 150 years or so. The cause of the change must have been the great increase in nutrients reaching the lake as the population of the area increased. There are plenty of plant nutrients in sewage, and it may be that modern farming has made the land yield more nutrients into the streams that pass over it.

Windswept margins Even on a productive lake it is not always easy to see a good example of a lake-edge (littoral) community. The shallow water at the edge of a lake that is not sheltered from the wind is a difficult habitat for living things. The chief problem is the backwards and forwards motion of the water created by wave action; it is even more difficult to cope with than the steady flow in one direction of water in a stream. Stones are constantly dislodged and silt is prevented from accumulating, so rooted plants cannot gain a foothold.

Nevertheless, in these inhospitable places the stones become covered with microscopic algae, especially diatoms, and mosses can become established. The diatoms provide food for small animals, and the mosses afford them shelter.

The lake limpet is one animal well-adapted

How lakes were formed

Most of Britain's upland lakes are glacial in origin. The great sheets of ice during successive ice ages dug out valleys and deposited rock and rubble at the lower end, forming a natural dam.

Lowland lakes such as Loch Leven were created when a melting sheet of ice left a shallow depression.

Loch Ness is an altogether different case. Rock faults running across the whole width of Scotland created its deep basin.

Lough Neagh in Northern Ireland was formed as the result of sagging. A large mass of volcanic lava subsided and created a hollow, which filled with water.

to the turmoil of a wave-swept shore. The broad sole of its foot acts as an efficient sucker to resist being dislodged by the movement of the water. The edges of its shell are soft, and fit into the irregularities of the stones on which it browses, eating diatoms and other algae. The little wandering snail, one of the most widely distributed molluscs in fresh water, is also equipped with a sucker-like foot that it uses to defy the movement of the water.

Other animals of this wave-swept habitat are flatworms, small leeches that can grip with powerful suckers at both ends of their bodies, freshwater shrimps and the larvae of a caddis fly, *Agapetus*, which fix their stone cases to larger stones.

In deeper water where wave action is less pronounced, dense growths of shoreweed and quillwort carpet the bottom and in deeper water there may be stoneworts such as *Nitella*.

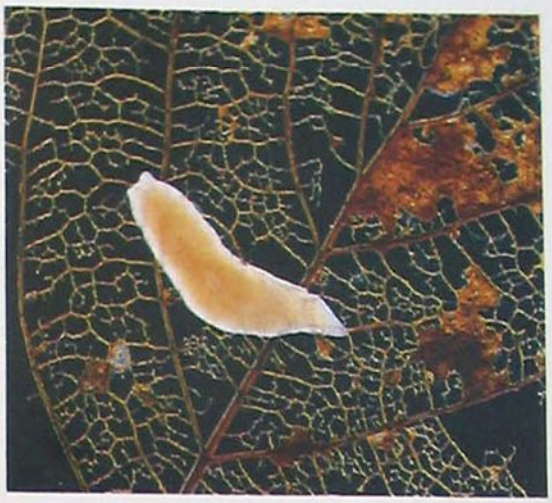
Sheltered shores On shores sheltered from the full force of the wind, communities of plants similar to those in a pond, described on page 158, may become established with submerged species such as water milfoil and Canadian pondweed, floating-leaved plants such as the yellow or white water-lilies, swamp plants including the common reed and finally marsh plants such as marsh marigold and yellow flag. The plants provide shelter for a range of small creatures: pond skaters, water bugs and beetles, and nymphs of dragonflies will be seen.

Open water When scientists study the open water community of a lake, they naturally have to row out to reach it. Since most of the plants and animals are extremely small, a plankton net is used. This is made of a fine-meshed material, and at its tip it holds a collecting vessel. When it is trailed through the water behind a boat this net will collect a 'broth' of living organisms which are channelled into the vessel. The organisms are then transferred into jars and dishes to be examined under the microscope.

The tiny floating organisms are called plankton; the plants (phytoplankton) include various kinds of algae, mainly diatoms. The small animals (zooplankton) include rotifers and crustaceans. The commonest of the tiny crustaceans are water-fleas such as *Daphnia* and copepods such as *Cyclops* and *Diaptomus*. Some of the lake fish, including charr, feed on these planktonic animals.

The fish represent the other end of the scale in the open water community. In productive lakes these are usually coarse fish such as roach, perch and pike. In unproductive lakes the game fish such as trout and charr are more characteristic. But if an unproductive lake is made richer by nutrients from man's activities, conditions become suitable for coarse fish.

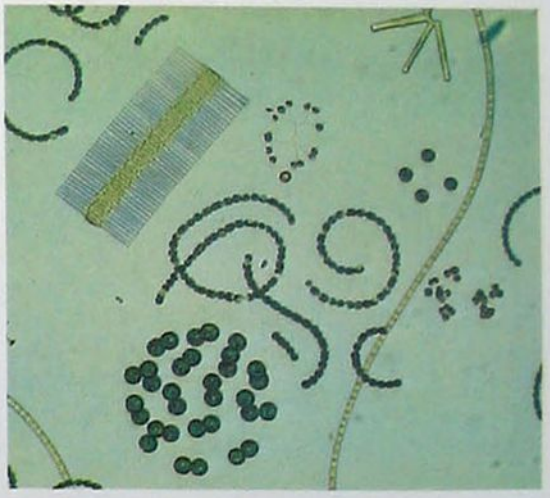
Seasonal variation In the early part of the year productive lakes are rich in nutrients which have been washed in by winter rains. The first spring sunshine leads to rapid



Above: An *Aeshna* dragonfly nymph, whose prey-catching mask is clearly seen from below. These carnivores are found among the plants in stiller waters, on sheltered lake shores.

Left: The unsheltered lake shore is constantly disturbed by waves. Some animals hold fast to a fixed object by suction. The creature crawling on this sunken leaf skeleton is a freshwater flatworm.

Right: A magnified view of the plant plankton typical of a productive lake. This sample was taken from Windermere. Where these microscopic plants are plentiful, animal life on a similar scale thrives.



Below: The common eel is one of the larger lake dwellers. It is a coarse fish, but unlike others in this group it is less confined to productive lakes and can adapt to various habitats.

Above: However productive a lake's water may be, a mature lakeside community including a succession of large plants cannot develop without truly sheltered conditions, away from the violence of the wind and waves.

growth of the plants, and consequently of the animals that feed on them. Some of the algae reach the point where they have used up certain essential nutrients. Silicates, for example, are present in only small quantities in lake water. Other algae are consumed by the small crustaceans, and are also liable to attack by minute fungi. Others fall victim to single-celled animal parasites called Proteomyxa, whose attacks can cut down the populations of algae in even large lakes such as Windermere.

The lake bottom In time, all living things die and drop to the bottom of the lake where decomposition – largely the work of bacteria and fungi – gradually converts the remains into simple chemicals that become once again the nutrients for further plant life.

The water of a deep lake is arranged in a structure, as shown in our diagram. The thermocline is a layer of still water which prevents movement from the lower to the upper levels. Its main ecological effect is to limit the movement of lake-bottom nutrients up to the layer where plants can use them. This explains why even large lakes do not support as abundant a plankton as might be expected from such a large body of water.

In spite of the inhospitable nature of those remote, cold depths, a few animals can live in the bottom mud of a deep lake. Oxygen is scarce but food, in the form of decomposing material, is abundant. Sludge worms have the same blood pigment as we have – haemoglobin, which enables them to make do with quite small supplies of oxygen. The worm-like larvae of some midges of the chironomid family are called bloodworms because they have the same red pigment in their bodies. They lie in the bottom mud or sometimes – if oxygen supplies grow unusually scarce – float up to join the creatures of the upper lake community.

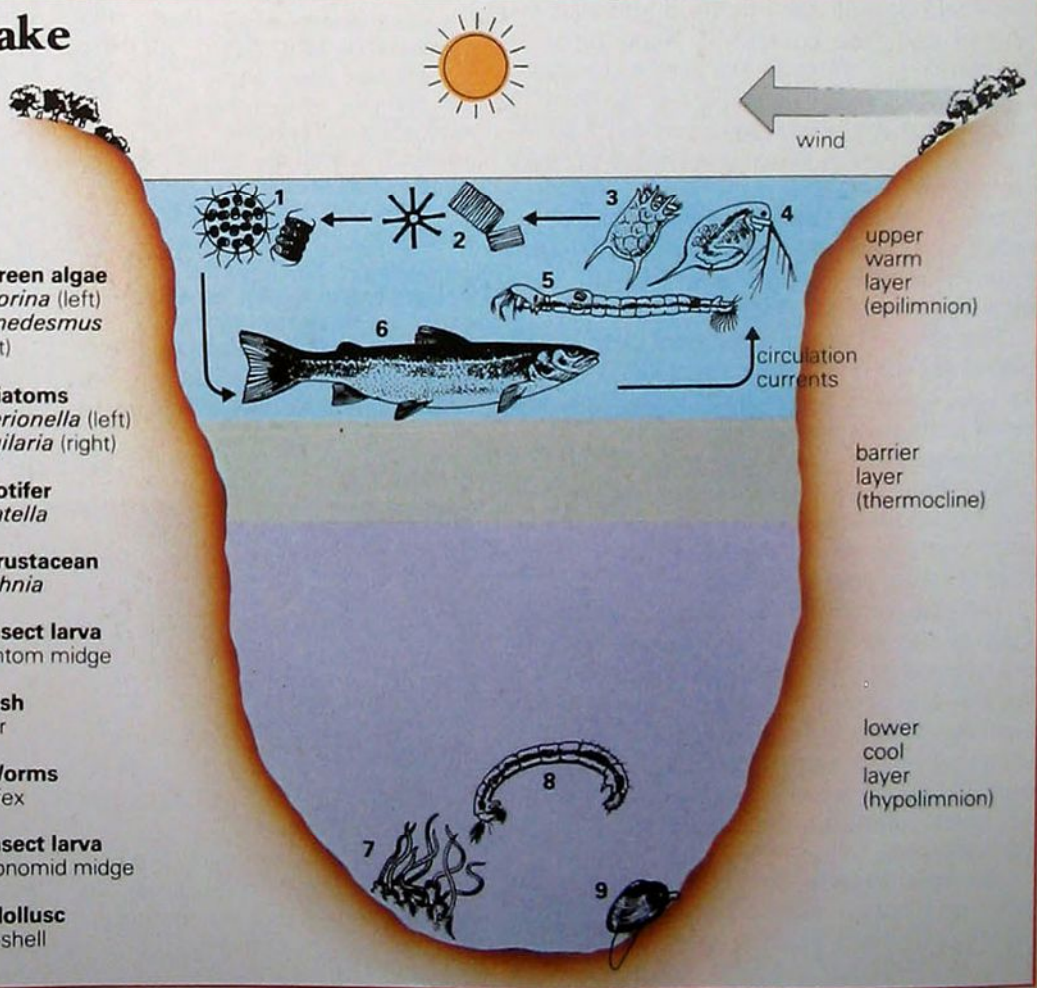
Layers of a deep lake

Warmth from the sun reaches a few metres below the surface, and wind produces mixing currents which carry the warmth downwards to about 15m (49ft). Plankton flourish in the warm upper layer. Below this lies a layer of cooler water, the thermocline, which acts as a barrier dividing the upper layer from the cold lower waters.

Dead remains of plankton and larger forms of life fall to the lake bottom and decay, so the lower layer contains nutrients that are created in the process of decay. Decay reaches its limits as the bacteria and other agents of decay use up the oxygen.

In the autumn the waters of all layers mix together (the overturn) as the upper waters on cooling become heavier. Thus some nutrients from below are recycled to the upper layer.

Note that the diagram is not to scale.



1 Green algae
Eudorina (left)
Scenedesmus (right)

2 Diatoms
Asterionella (left)
Fragilaria (right)

3 Rotifer
Keratella

4 Crustacean
Daphnia

5 Insect larva
phantom midge

6 Fish
charr

7 Worms
tubifex

8 Insect larva
chironomid midge

9 Mollusc
pea-shell

ROWAN: HARDY MAGICAL TREE

The rowan has something to offer for most of the year. Its graceful foliage emerges in spring, splashes of white blossom appear in summer, and in autumn and early winter the tree is decorated with dense hanging bunches of bright red berries.

The rowan is a native tree most usually associated with high country. Indeed, it is also known as mountain ash, but is totally unrelated to the common ash (see page 241) and differs in all respects apart from its compound leaves.

In the British Isles rowan grows at altitudes up to 950m (3115ft) which is higher than any other native broadleaved tree. It also occurs throughout the lowlands, favouring sandy or gravelly soils which tend to be rather acid. On bleak mountainsides it forms a stunted, windswept tree only a few metres tall, but on the more sheltered lowlands it can reach 20m (65ft) in height. Because its berries are devoured by birds and the seeds widely

dispersed in their droppings, the rowan appears in a variety of habitats including woodland, scrubby hillsides, heaths and hedgerows.

Multi-purpose species The rowan's versatile form has, not surprisingly, made it a firm favourite with landscape gardeners. It is widely planted in parks and gardens, on motorway embankments and golf courses, for it stands up well to the stresses of urban life. Foresters have also used it as a nurse tree in plantations of hard woods when the light shade of its foliage promotes the growth of the hard wood saplings – until they eventually outgrow it and form a close canopy which is often too dark underneath for the rowan to survive for long.

Handsome appearance The slim trunk is covered with smooth slate-grey bark which is marked with shallow horizontal scars. The limbs tend to grow upwards to form a rather loosely branched crown which allows plenty of light through and so does not appreciably suppress plant growth beneath. The twigs are pale brown, sometimes tinged with violet. The alternate buds, 10-15cm (4-6in) long, and the brownish-purple bud scales are fringed with fine silky white hairs.

The foliage unfurls towards the end of April. The leaf stalks, 10-25cm (4-10in) long, bear from five to eight opposite pairs of leaflets and are tipped with a single terminal leaflet. Each leaflet has serrated edges and is bright green on its upper surface, but paler underneath.

Above: Rowan berries are rich in Vitamin C and can be made into delicious jelly that goes well with game.

Below: Rowan flowers have a sweet, musty smell, rather like hawthorn blossom.

Rowan leaves fall relatively early in the autumn, but not before they have acquired colourful autumn tones of yellow and orange.

The rowan blossoms in May or June, producing dense, flat-topped inflorescences made up of many tiny flowers, each with five creamy white petals. Although the individual flowers are very small, because they are tightly packed together they are conspicuous and attract a variety of prospective pollinators, including flies, beetles and bees.

After fertilisation the flowers are succeeded by green berries. They ripen by September and provide a glorious display of bright, shiny fruits varying in colour from orange to scarlet. Generally this attractive sight is short-lived, because birds find the fruits irresistible and soon strip the trees bare.

Blackbirds, thrushes, fieldfares and redwings all take their share. The handsome waxwing, a winter visitor from northern Europe, which in some years migrates here in large numbers, is particularly fond of rowan berries. It has been reported that bird-sown rowan seeds germinate the following spring, whereas normally they remain dormant in the soil for 18 months. This may be due to the abrasive action of the bird's gut which acts upon the seed-coat, allowing moisture to enter, so germination occurs sooner than usual when the berries fall to the ground.

The rowan's Latin name, *Sorbus aucuparia*, means 'fowler's service tree', which refers to the past use of the berries as bait by bird trappers. In some districts the berries are known as 'hen-drunks', because chickens apparently became intoxicated after gorging themselves on the fallen fruits. In Wales the berries were fermented in ale to produce an alcoholic drink with similar effects.

To the human palate the fruits have a rather harsh, sour taste, but they are still used to make jelly that goes well with game dishes such as hare and venison.

Magical tree The rowan has a special place in our folklore, especially in northern regions. Many of the superstitions connected with it originated from ancient Nordic visitors from Scandinavia. The word rowan is probably derived from the Norse *runa*, which means a charm, and relates to the tree's reputation for warding off evil.

In Scotland and Ireland the rowan's magical powers were greatly revered. A branch was always nailed to cattle sheds to protect the animals from witchcraft and sorcery. Similarly Highland crofters planted a rowan tree outside their homes to keep witches at bay. Indeed, another local name for the tree is witch-wood, and an old rhyme sings its praises:

Rowan tree and red thread,
Hold the witches all in dread.

In Wales, Ireland and some northern counties of England, the rowan was often planted in churchyards. This was to keep the dead in their graves and prevent any ghosts appearing in the neighbourhood.

The wood is dense and strong and was valued by crofters living in the sparsely wooded glens of Scotland and Ireland.

Above **Rowan** (*Sorbus aucuparia*) or **Mountain Ash**. Native, deciduous, grows to 20m (65ft) in woods, on scrubland and mountains especially in the north and west. Flowers May, fruits September onwards.

Below: The rowan in full fruit growing on Dartmoor.

SEA-SQUIRT: MAN'S FAR RELATIVE

Sea-squirts were classified as molluscs, until a tadpole-like larval stage was discovered. This related them to animals with backbones, and therefore to man himself.

Sea-squirts are soft, gelatinous marine animals whose bodies are attached to rocks, stones and weeds on the lower shore and the sea bed. Some of the British species are rather drab in appearance and easily missed by the beachcomber or diver; however, a few are beautifully and delicately coloured. About 60 species, ranging in size from the microscopic to 15cm (6in) tall, have been recorded from locations all round Britain.

The most familiar sea-squirt, *Ciona intestinalis*, is widely distributed in shallow and deep water, and grows well in harbours with suitable attachment areas, such as piers, pilings and harbour walls. It is often found on the cooling inlets of industrial installations, as well as on more natural rocky surfaces.

Body in two parts *Ciona* has a tall, rounded tubular body divided into two basic regions: the upper gill, or branchial region, and the lower stomach, or abdominal region. It has no head or limbs. The branchial region of all sea-squirts bears two openings (siphons). One is situated at the top of the body and is usually quite large and conspicuous; this siphon allows water to enter the branchial region. The other siphon, which is below the terminal opening, releases water from the body.

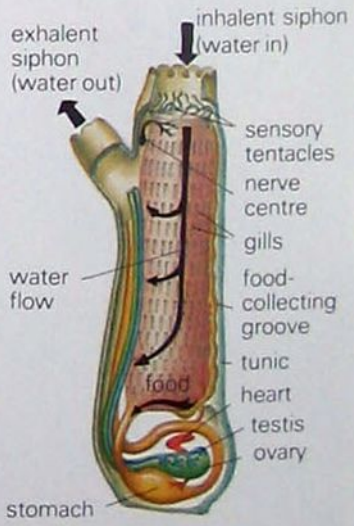
Where the two regions join is not clearly visible because of the thick protective coat, called the tunic, which surrounds and supports the animal. This tunic is made of a substance similar to cellulose, and may be smooth, warty or very thick depending on the species. In *Ciona* it is semi-transparent and the internal organs can be made out within. It is also thick which probably deters large predators from attacking: a few sea-squirts are eaten by marine snails however.

The body wall itself contains muscles with which the animal can make limited changes of shape. Most noticeably there are muscles running up and down the length of the body with which the animal can contract itself.

The sea-squirt can close its siphons almost completely by contracting a muscle ring located in the lip. This also helps prevent

Above: A colony of sea-squirts (*Distoma variolosa*) cluster on rocks.

Anatomy of a sea-squirt



Above: The internal anatomy of a sea-squirt is adapted to filter sea water for food, bring in oxygen and carry away waste products. There are two main parts: the gill region and the gastric region.

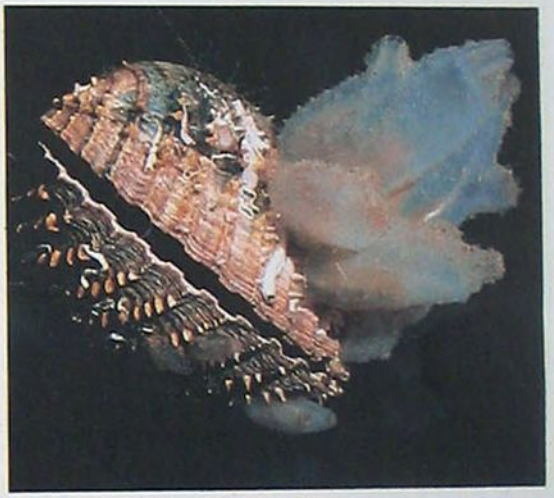
small predators from entering to eat away at the internal organs. If a predator does get in, however, the sea-squirt may resort to contracting the branchial region, which holds some water, and squeezing out the intruder in a jet of water – hence its name.

Feeding and breathing gills Sea-squirts, as with many sedentary marine animals, use their gills both for respiration and filter feeding. The gills are arranged like a cylinder of fine mesh. Water is pumped into the middle of the gill cylinder via the top inhalant siphon. It is forced through the fine mesh of the gills by thousands of minute, beating, hair-like structures called cilia. As inhalant water passes through, dissolved oxygen is extracted from it and passed into the blood vessels of the sea-squirt, while carbon dioxide is released by the gills into the sea water. At the same time particles of food, such as minute planktonic plants and animals, are filtered from the water and passed by special cilia in a collecting groove into the gut.

The abdomen houses the heart and sex organs as well as the stomach and intestines. Waste products from the digestive processes, as well as sperm and eggs from the sex organs, are released via ducts into the outer sleeve surrounding the gills so that all these materials are swept out of the exhalant siphon along with the exhaust water.

The nervous system is poorly developed and there are few sense organs. The blood system is strange in that blood is pumped by the simple heart first in one direction and then the other. There are few blood vessels, blood for the most part percolating between the organs. Such a system serves to distribute digested food and oxygen through the body.

Above: These sea-squirts *Dendrodea grossularia* are rather squat and dome-shaped, with a rough red-brown surface.



Right: A common sea-squirt, *Ciona intestinalis*, attached to a spiny cockle shell. It also anchors to other organisms.

Below: The distinctive tubular body of *Ciona intestinalis* may reach 12cm (4½in) high. The siphons have puckered lips rimmed by yellow pigment.

Link with man It was by studying the development of fertilised sea-squirt eggs (sea-squirts are generally hermaphrodite and fertilisation of the eggs by sperm occurs in the sea), that scientists realised the real level of these animals in the animal kingdom. Originally they had been classified with the molluscs, possibly because of their large gill regions.

However, it was discovered that the developing sea-squirt egg produces a swimming larva nothing like those of the molluscs; but rather like a minute tadpole complete with a rudimentary head and gelatinous, stiffening rod resembling the most primitive backbone (see illustration). Both these structures are completely lacking in the adults. From being regarded as simple molluscs, sea-squirts were recognised as chordates which bear a common, if distant, ancestry with backboned animals such as fish, amphibians, birds and mammals including man.

The fertilised eggs have also been used by scientists investigating the way embryos develop. They are especially suitable for this as the whole process from fertilisation to metamorphosis of the larva is very short.

BUGS THAT STINK TO DEFEND

The shield-like shape of the body gives shield bugs their name. If you handle one of these striking insects, you'll soon find out why they are also known as stink bugs.

Above: The forest bug (*Pentatoma rufipes*) is most common on oaks, but feeds on various deciduous trees and shrubs and also occasionally attacks caterpillars. It hibernates as a young nymph and completes its growth in early summer. Newly hatched shield bugs are wingless at first, wing buds appearing after the first moult. The wings reach full size when the insects become adult at the fifth moult. There is no pupal stage.

The shield bugs belong to several closely related families of the Heteroptera–a subdivision of the order Hemiptera. The front wings are largely horny, but their tips are always membraneous–thus giving rise to the name of the order, which simply means 'half wings'. The membraneous wing tips readily distinguish the insects from beetles. In addition to the overall shield-shape, most species have a triangular shield, known as the scutellum, in the middle of the back.

Shield bugs can be found on the ground, on low-growing vegetation, and in trees. Most of them are able to fly well, but they generally take to the air only in hot weather and are more likely to scuttle away when disturbed. They are right on the edge of their range in Britain: we have less than 40 species and most of these are confined to southern areas. Our damp winters are largely to blame for this, since most of the species hibernate as adults or nymphs and are vulnerable to attack by fungi in damp conditions. It is significant that most of our shield bugs live on the lighter and better drained soils. Relatively low summer temperatures may also help to keep numbers down, for populations rise considerably after the occasional hot summer.

Smell and colour If you pick up a shield bug you'll soon discover why the insects are also known as stink bugs, for most of them exude a strong-smelling fluid which may well stain your hands. The fluids of some species are decidedly unpleasant and they effectively deter birds and other predators. Species with particularly pungent odours are often further protected by coloration: bold patterns –commonly of red and black–warn potential enemies to keep their distance. Young birds will try these boldly marked insects, but they very soon associate the colours with an unpleasant taste and leave them alone.

The fluids exuded by some of the British species are not particularly unpleasant smelling and, judging by the rate at which birds eat the insects, they confer no protection. These shield bugs rely more on camouflage, and in this respect none is better equipped than the common green shield bug.

One of our commonest shield bugs, this green bug can be found on a wide range of plants and deciduous shrubs, although its coloration makes it difficult to spot. It hibernates in the adult state, and towards autumn assumes a deep bronze colour which effectively hides it among the dead leaves. By the time it wakes up in the spring, the bug has become bright green again and blends perfectly with the young leaves.

A liquid diet As true bugs, the shield bugs all have needle-like mouthparts with which they take in liquid food. Most are herbivores, plunging their 'beaks' into plants and sucking out the sap. If you suddenly pull a feeding bug from its foodplant you may well see a clear bead of sap oozing from

Above: The female birch shield bug (*Elasmostethus interstinctus*) guards her batch of eggs from parasites by sitting on them until they hatch.

Common green shield bug (*Palomena prasina*). 13mm ($\frac{1}{2}$in).

Negro bug (*Thyreocoris scarabaeoides*). 4mm ($\frac{1}{6}$in) long.

Hawthorn shield bug (*Acanthosoma haemorrhoidale*). 15mm ($\frac{5}{8}$in).

Parent bug (*Elasmucha grisea*).

Pied shield bug (*Sehirus bicolor*). 7mm ($\frac{1}{4}$in) long.

Forest bug (*Pentatoma rufipes*). Adult is 13mm ($\frac{1}{2}$in).

Shield bug (*Picromerus bidens*). Carnivorous. 13mm ($\frac{1}{2}$in).

Right: Nymph of common green shield bug (*Palomina prasina*) feeding on the berries of bittersweet (*Solanum dulcamara*). Note the developing wing buds.

the sharp tip of the beak.

The insects rarely do any damage in Britain. The common green shield bug occasionally affects broad beans and other leguminous crops, while cherries are sometimes infested by the forest bug. This is a sombre brown insect, often with a metallic orange tinge, and is easily identified by the prominent orange spot at the hind end of the scutellum.

Egg-laying Female shield bugs lay their eggs in small batches, sometimes on the ground, but usually on the foodplant. Seen under a microscope, the eggs often look like miniature barrels, complete with lids. The nymphs emerge by pushing off the lids, often aided by a spike known as an egg-burster.

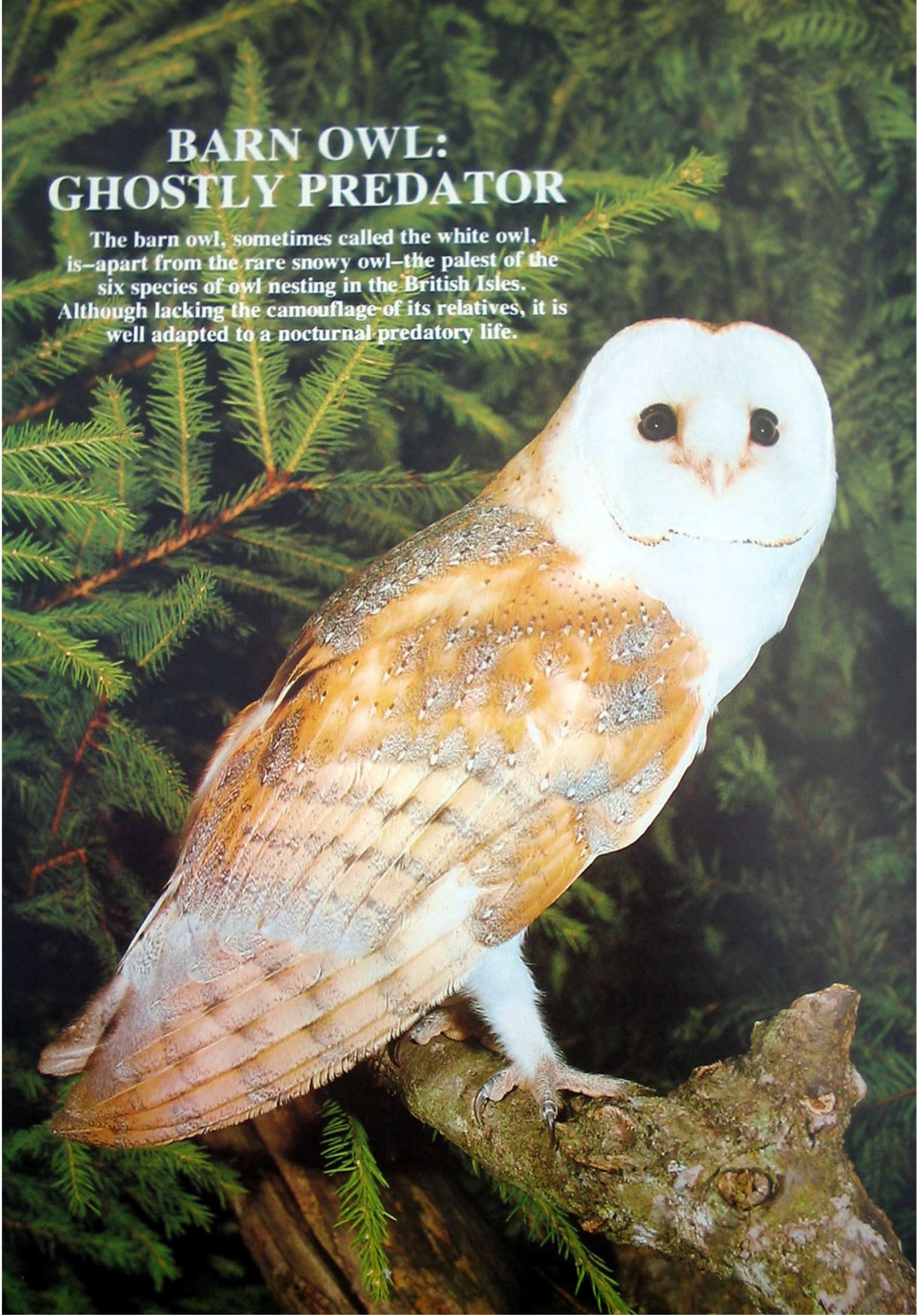
The eggs are normally abandoned as soon as they are laid, but the well-named parent bug displays a remarkable degree of parental care. This attractively mottled species is often abundant on birch trees. Like another species, the birch shield bug, the parent bug female lays its eggs in a compact diamond-shaped mass and then sits over them until they hatch. By brooding the eggs in this way, the female protects them from various parasitic wasps.

The female parent bug continues with her duties even after the eggs have hatched, shepherding the brood over the leaves and quickly covering them with her body when danger threatens. The youngsters gradually disperse during the summer and hibernate as adults in leaf litter.

Three common species A certain degree of parental care is also shown by the pied shield bug. This neat black and white insect can be found in nearly every clump of white deadnettle in southern Britain. The female lays a loose ball of eggs in the soil in late spring and guards it jealously until the eggs hatch. She then leads the nymphs up to the foodplant, where they scatter and feed on the developing fruits. The nymphs mature during the summer and hibernate in the adult state, often burrowing 15cm (6in) into the soil.

The negro bug is much more beetle-like than the other shield bugs and has a much more rounded shape. The scutellum is greatly enlarged, extending right back over the abdomen and almost completely concealing the wings. No more than 4mm ($\frac{1}{6}$in) long, it lives on sparsely vegetated ground in warm and well-drained situations. It is most common on coastal sand dunes, but also occurs on southfacing hillsides in southern Britain. It hibernates in the soil in the adult state. Both sexes produce chirping sounds by rubbing the abdomen against the underside of the hind wing.

The hawthorn shield bug is one of our most striking species, up to 15mm ($\frac{5}{8}$in) long and claret and green in colour. The adults appear in August and feed on the leaves and especially the fruits of the hawthorn before going into hibernation in dark bark crevices. Eggs are laid in spring and the nymphs feed on the hawthorn leaves. The species is not uncommon in town parks where hawthorns are grown.



BARN OWL: GHOSTLY PREDATOR

The barn owl, sometimes called the white owl, is–apart from the rare snowy owl–the palest of the six species of owl nesting in the British Isles. Although lacking the camouflage of its relatives, it is well adapted to a nocturnal predatory life.

The barn owl, probably the best known and most widely distributed owl in the world, is primarily a tropical species. Most live between the latitudes of 40°S and 40°N of the equator, and in Scotland barn owls are at the northernmost part of their range. They seem to benefit from Britain's relatively mild maritime climate, the winters in other countries further from the sea being, by comparison, too harsh. However, even in the British Isles, barn owl numbers are severely reduced in cold winters, and they tend to avoid mountainous areas.

Most owl species are well camouflaged so they can rest in trees during the day without being constantly mobbed by other birds. The barn owl, with its white face and underparts, has no such camouflage, so it hides away in holes and old buildings by day to avoid being noticed. Females are larger than males and tend to be greyer above and slightly spotted below. On the continent, and occasionally in south-east England, you may see very grey-looking barn owls with buff-coloured breasts.

Barn or tawny? Barn owls are smaller than tawny owls (see page 13) and have even been killed by them. However, they usually avoid competition for food and nesting sites by staying outside the tawny owl's woodland habitat. Also, the barn owls' wings are relatively longer than the tawny owls' and therefore more suitable for flight over open ground than among trees. Barn owls prefer to hunt over rough grassy areas, farmland, marshes and bogs, scrub and young forestry plantations.

Unlike tawny owls, barn owls do not call. They mark out their territory with a wild shriek, often made while flying. If you approach a nest you may hear the parents or

Above: A clutch of seven young chicks peer out from their hay-loft nest.

Below: The female owl, in a crouching, defensive posture, shelters her young behind her spread wings.

Opposite: The male barn owl has a white face and underparts. The upper parts are orange-buff, delicately spotted with grey, brown and white, while the tail has four greyish bars.

Right: The female barn owl, larger than the male, is greyer above and slightly spotted below.

young birds hissing ferociously or perhaps making a snoring noise. Alarmed barn owls also make an audible snap with their beaks.

Man-made homes Holes in old, fairly isolated trees, rock crevices and old nests of birds like the jackdaw are often used to rear the barn owl family. However, many barn owls depend on man-made nest sites such as barn lofts, unoccupied buildings, ruins and church towers, even in the middle of towns. Many old barns were made with a special hole high on an end wall to encourage barn owls to nest inside and hence control the local population of mice.

Even modern barns can be adapted by cutting an access hole about 20cm (8in) square. Some barn owls have been trapped inside buildings when the doors were closed and there was no other way out. Recently, in buildings where suitable nesting ledges are not available, they have readily taken to large nest boxes placed in a high, dark corner. We should be careful to make sure they have somewhere to nest, especially as their more natural nest sites are becoming scarce.

Incubating the eggs Barn owls do not add any nesting material to the chosen site, although an untidy scattering of pellets might provide some sort of bed for the eggs. The female usually lays three to seven eggs (though sometimes up to 11) at two to four day intervals, generally in April or May. Their eggs, like other owls', are white; but unlike the normal spherical shape of owl eggs, the barn owl's are oval.

Survival of the fittest Successful nesting is dependent on the availability of food; in good years barn owls may breed in almost any month. Like other owls, the female starts incubating as soon as the first egg is laid, each egg hatching after about a month. During this time the male brings food to his mate at the nest; later on, both parents have to work hard to satisfy the growing family. If, when the chicks are young, food becomes short, the last to hatch–and therefore the smallest–may not survive. The larger chicks are given what food there is to make sure that when they leave the nest in late summer they are healthy enough to survive in the wild. More food means more chicks survive, and also gives the adults a chance to rear a second brood.

Owlets Newly hatched owlets are covered in short, white down, but they replace this after a week or two with thicker creamy-buff coloured down. It is 9 to 12 weeks before the owlets leave the nest and even longer before they can hunt for themselves. By this time they have grown their third coat of feathers, like that of their parents, though you may see some fluffy remains of down. Despite the young owls' natural instinct to hunt and kill their prey, they must learn, often by trial and error, how to do it efficiently. If they manage to survive the first winter they can raise their own family the following year.

Visions of the night The barn owl sees on the darkest night and can spot prey clearly while remaining unseen itself. Most birds avoid flying at night because they cannot see clearly. Long migrations are often made at night, but usually at great heights–away from dangerous obstacles. However, barn owls' eyes are specially designed for night vision, and are forward-facing to give them a wide degree of binocular vision. They can therefore fly in safety and hunt with astonishing efficiency.

Stealthy hunter Most diurnal birds of prey rely on speed of flight to catch their prey, but the barn owl is master of the silent approach and surprise attack. The unfortunate prey gets no warning because marvellously soft plumage and several hundred sound-deadening hair-like projections on the owl's wing feathers enable it to fly in complete silence.

The barn owl's head looks enormous, but it is exaggerated by feathers that form a characteristically heart-shaped facial disc.

Barn owl (*Tyto alba*), 34cm (13½in) from beak to tail. Distribution widespread.

Opposite: The bulk of the barn owl's diet consists of field vole, common shrew, wood mouse and brown rat. Once captured, the prey is swallowed whole or taken back to the nest site (in this case an old brick loft) where it is torn to pieces for the hungry chicks. Indigestible parts are later coughed up in shiny, blackish pellets about 5cm (2in) long by 2·5cm (1in) wide.

male in flight

male hovering

The barn owl has a very light body compared with the area of its wing (technically known as a low wing bearing). This makes it buoyant in flight, and eliminates the need to flap quickly; the barn owl often glides (above left). As it searches methodically for prey it hovers (above) over ditches and by hedges. The barn owl also dangles its long, feathered legs ready to make a quick kill and can move the outer toe to maximise the deadly grip of its sharp, curved 10cm (3-4in) long claws (left).

In the same way that a dog raises and twists its external ear flaps, the barn owl moves these feathers to focus tiny sounds onto its large, sensitive ears–especially receptive to high-pitched sounds like the squeak of a mouse. On very dark nights the owl can range in on its prey by sound alone.

On the other hand, barn owls see perfectly well in bright sunshine, as the pupils in their eyes contract to cut out excess light. You are most likely to see them hunting at dawn, in the afternoon in winter when food is short, or when they have a family to support. Sometimes you may see barn owls perched on fence posts or other vantage points waiting for unwary quarry to pass beneath. You are, however, more likely to see them in flight.

Carnivorous diet Barn owls live on animals that man regards as pests and are certainly more efficient at controlling the rat population than cats or poison. In England, Scotland and Wales, voles and shrews are the most often caught–but only if they are available close to the nest site. However, in Ireland and the Isle of Man, neither short-tailed voles nor common shrews are found.

Sometimes barn owls catch small roosting birds like starlings and sparrows, and they have been seen plunging feet first into water like an osprey to catch fish. They are also known to eat frogs, beetles, moths and bats, but only rarely do they take larger prey such as rabbits.

Of all owls, the barn owl is the most closely associated with man. But for centuries it was regarded with extreme suspicion and attributed all sorts of evil powers. This is, perhaps, not surprising since it seems to thrive in many of the situations we would find unfamiliar and uninviting. Since it depends on the silence of the night to hear and locate the squeaks and rustlings of its prey, it favours such places as lonely ruins and churchyards for hunting and nesting.

In flight, or perched upright on a post, the barn owl has a ghostly man-like appearance with long legs and a distinct face in which the forward-facing eyes and hooked beak are situated just where we would expect our own eyes and nose to be.

Mortality Many barn owls are hit by fast-moving cars and trains, and some collide with wires in strong winds. In this country information from ringed birds has shown that very few live for more than eight years. In the past there was a time when barn owls were frequently shot because, along with all other predatory birds, they were thought to kill game birds.

More recently, population declines have been attributed to the use of toxic chemicals in agriculture. Add to this a steady reduction in good habitat and it is not surprising, though sad to say, that barn owls are not as common as they once were.

COLOURFUL PLANTS OF LATE SUMMER

As summer draws to a close there are numerous species of flowering plants which still provide a marvellous array of colours. Some, like the autumnal crocus, are rare and you have to look hard for them in the grass; others, such as members of the daisy family, are tall and widespread.

Several native or introduced species which were grown in cottage gardens for their supposed medicinal properties have escaped from cultivation and become naturalised. Others have become so invasive that they are classed as weeds, and are no longer welcomed in the garden. Many, like nipplewort and groundsel, have gained wide distribution, and they bloom over a long period.

The large bindweed or bellbine is a vigorous climber which is native in Europe and North America. It twines in an anticlockwise direction, and in warm sunny weather it can make a complete revolution of its support in as little as two hours. Where there is no support, the stems twine round one another to form a thick rope-like structure. The smooth stems are angled.

The dark green leaves, often with a bluish tinge, are large and roughly heart-shaped and borne on long stalks. The handsome white trumpet-like flowers are about 7cm (3in) wide, making them one of the largest of all British wild flowers. They sometimes have pale pink stripes.

Like native bindweed or cornbine, large bindweed does not set seed easily, but reproduces readily by vegetative means. Once it has become established, it is difficult to eradicate.

Feverfew is a tall perennial herb with yellowish-green pinnate leaves which have deeply cut segments. The white, daisy-like flowers have numerous yellow disc florets.

Feverfew is a medicinal plant. An infusion of the strongly scented leaves was believed to banish fevers and headaches–hence its common name. A native of Europe, it is also a herb garden escape. Both double and single forms are grown in gardens, and the dwarf golden form is used for edging flower beds. The seedlings are so prolific that it is also a difficult species to eradicate once

Opposite: **Autumnal crocus** (*Crocus nudiflorus*) flowers Sept-Oct in damp meadows, woods. Rare in the wild. Ht 10cm (4in).

Above: **Large bindweed** (*Calystegia silvatica*) flowers July-Sept in hedges, thickets and on waste ground. Climbs several metres.

Right: Common ragwort is a troublesome species on agricultural land. An average-sized plant can produce 50,000 seeds, 80% of which will germinate.

it is established.

The autumnal crocus, or naked autumn crocus as it is sometimes known, is a native species of north-west France and Spain. It grows best in dampish areas of gardens but it is naturalised in a few local districts where it may be quite prolific. The three to five strap-like leaves appear in spring but die down by the time the beautiful flowers emerge in autumn. This species is often confused with the meadow saffron or autumn crocus (*Colchicum autumnale*), but you can distinguish the two by the number of their stamens. The autumnal crocus has three stamens and the meadow saffron six.

Stinking groundsel was first sighted in the Isle of Ely in the 17th century and is now a widespread species. Although it is similar to the common groundsel, this south European native does have distinguishing characteristics. The general stickiness of the plant comes from the many glandular hairs–hence another of its common names, sticky groundsel.

The yellow ray flowers usually have about 13 petals which bend back as the flower develops. It has been estimated that each flower head contains about 70 seeds, and so the average annual production by one plant over its long flowering period is potentially colossal. However, many of the seeds formed at the end of the season are often sterile.

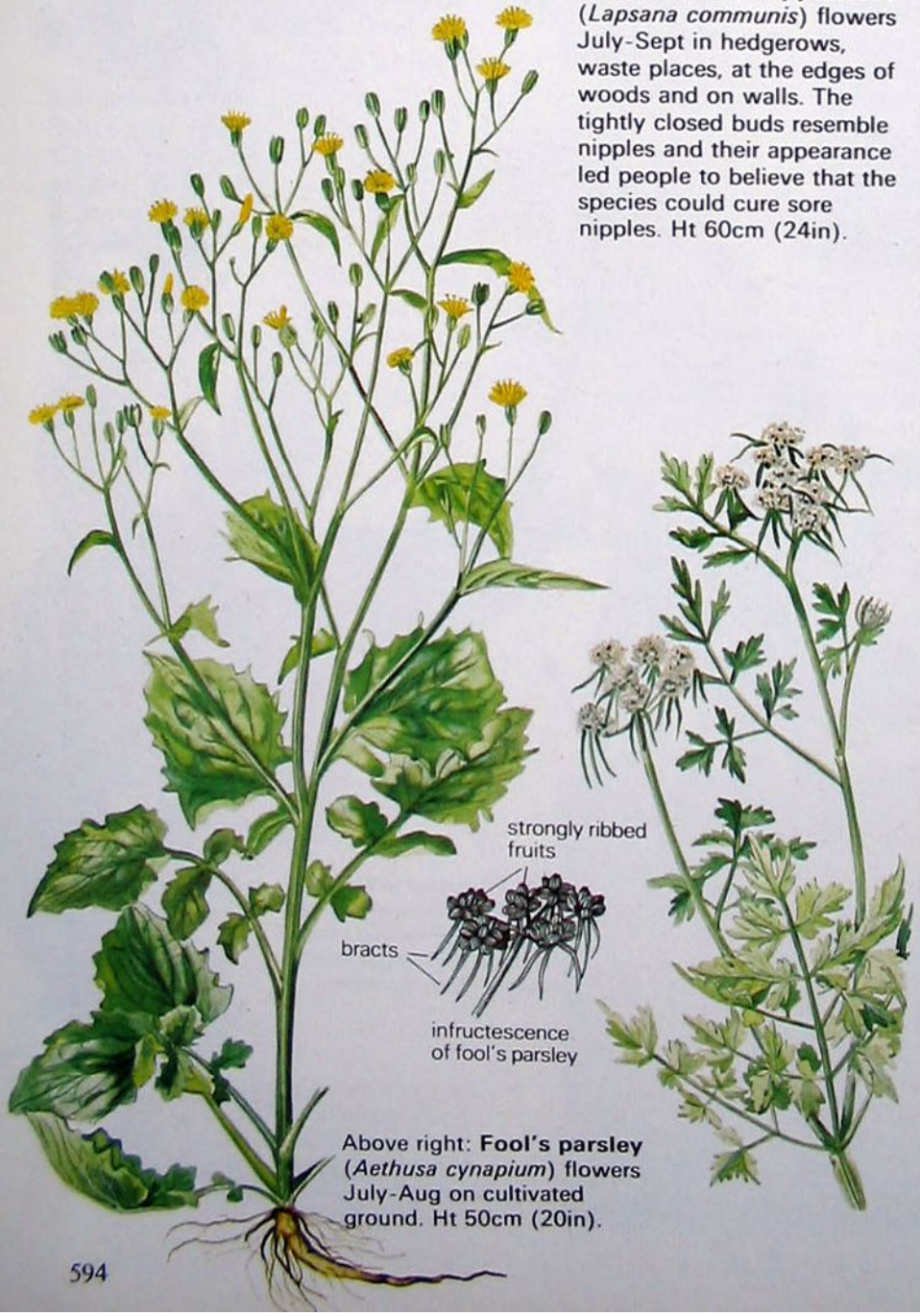
Common ragwort, like Oxford ragwort, is a

Right: **Common ragwort** (*Senecio jacobaea*) flowers June-Oct on waste ground and arable land. Ht 120cm (48in).

Left: **Feverfew** (*Chrysanthemum parthenium*) flowers July-Sept on walls, in waste places, hedgerows. Ht 50cm (20in).

Left: **Stinking groundsel** (*Senecio viscosus*) flowers July-Sept on waste ground, by roads and tracks and by the sea. Ht 50cm (20in).

Above and left: **Nipplewort** (*Lapsana communis*) flowers July-Sept in hedgerows, waste places, at the edges of woods and on walls. The tightly closed buds resemble nipples and their appearance led people to believe that the species could cure sore nipples. Ht 60cm (24in).



Above right: **Fool's parsley** (*Aethusa cynapium*) flowers July-Aug on cultivated ground. Ht 50cm (20in).

weed of waste ground and over-grazed pastures. It is taller than the Oxford ragwort, the bracts are brown-tipped rather than black-tipped, and the leaves are a greyer green and very divided. It is a particularly attractive species to bees because of its copious supply of nectar and pollen. The whole plant is bitter and contains a poison; if animals eat too much of it, they can eventually die. Yet it is a popular food of the cinnabar moth.

Nipplewort was once thought to have medicinal properties that cured sore nipples, but now it is simply regarded as a weed. A much-branched annual, its slightly hairy lower leaves are rounded with a few small lobes along the stems, whereas the upper leaves are much narrower and entire. The small yellow flowers look rather like dandelion blooms. They open early in the morning and close before noon; on very dull days, however, they do not open at all.

Fool's parsley is an annual species with dark green leaves that are very like those of parsley; when rubbed, the leaves and stems give off an acrid smell. All parts of the species are poisonous, and illness can be caused if it is eaten in mistake for parsley–hence its common name. The small white flowers are borne in an umbel. The bracts under the smaller umbels point downwards, so making them a distinctive feature. The smooth oval fruits are green.

Above: Feverfew flowers in profusion in summer and is especially common on walls. It was thought to be an particularly effective cure for feminine ailments.

BRITAIN'S BIGGEST VOLE

Not to be confused with a rat, the water vole (below) is an expert swimmer, using its feet in a kind of dog-paddle. It can be spotted, day or night, near lakes, streams and rivers.

Water voles are readily distinguishable by their large size from the mouse-sized bank and field voles which live only on land. In some parts of Europe water voles live as land voles; and because it was thought that the two types were different species, each was given its own scientific name. It is now known, however, that the large voles, both water and land-loving, are all the same species and must therefore have the same name. This is why Britain's water voles have the apparently contradictory name of *Arvicola terrestris*; *terrestris* refers to the terrestrial habits of their continental cousins.

Water-lovers Although water voles feed almost entirely on land plants, they nearly always live close to water, especially on the densely vegetated banks of lakes, slow-flowing rivers, streams and ponds, as well as by canals and drainage ditches all over Britain. There are just a few places in Britain where water voles are common away from water, where they burrow like moles in pasture. The colony of water voles on Read's Island in the estuary of the River Humber, for example, has flourished because there are no rats on the island to prey upon them.

Ratty Kenneth Grahame's book *Wind in the Willows* calls Mole's friend Ratty– although the pictures show him to be a vole. If you see a brown or black mammal, about 30-45cm (12-17½in) in length, swimming with just the top of its head, back and tail breaking the surface, it is either a rat or a vole. A vole is distinguished by its rounded face (which resembles that of a small guinea

WATER VOLE
(*Arvicola terrestris*)
Size Males 19cm (1½in) head and body plus 12cm (4¾in) tail. Females 18cm (7in) head and body plus 11cm (4½in) tail. Adult weight in breeding season 230-260g (8-9oz).
Colour dark brown shaggy fur, lighter brown or brownish grey underneath. Black varieties common in N Scotland.
Breeding season from April to September.
Gestation period 3 weeks.
No of young 2-3 litters of 5 per female each year.
Lifespan 12-18 months.
Food Vegetable matter, especially the stems of waterside grasses and other green plants.
Predators Pike, heron, weasels, stoats, mink and most other predatory mammals, especially brown rats, and birds of prey.
Distribution All over Britain, but rare in NW Scotland; not Ireland.

Water vole or brown rat?

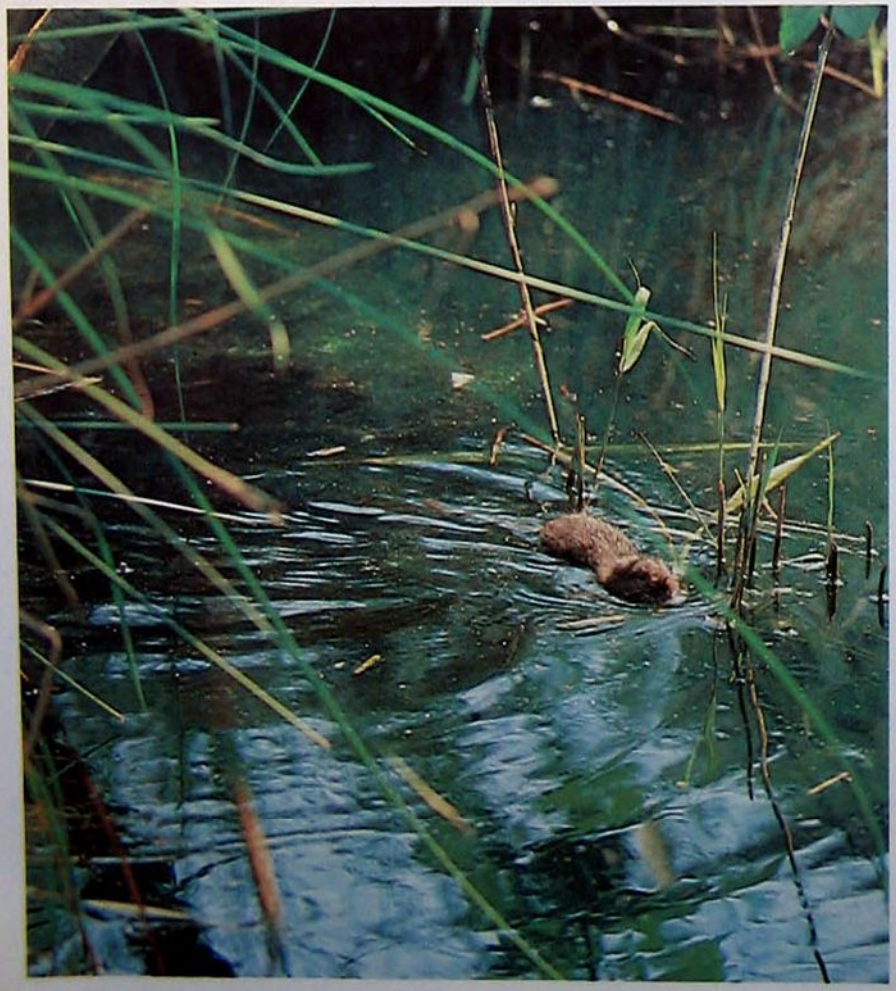
Above: The water vole (left) is often confused with the brown rat (right), which also lives along riverbanks and swims just as well. The vole has been called a 'water rat', but rats have a longer tail, longer ears and a more pointed face.

Below: Water voles plunge into the water to escape predators. All four feet are used in a dog-paddle. The under-fur is protected by long 'guard' hairs, which give water voles a shaggy appearance.

pig), smaller eyes, shorter muzzle and shorter ears which project just beyond its fur. A rat's tail is as long as its head-and-body length, while a vole's is about half or three-quarters of the total length of the head and body.

Enemies The greatest threat to the survival of the water vole is probably represented by brown rats. Rats can kill and eat baby voles and may even overpower a young vole. In areas where rats have become common on riverbanks, water voles have become rare or disappeared completely.

Apart from rats, all the usual predators of small mammals–such as weasels, stoats, mink and birds of prey–eat water voles. The water voles' habit of swimming and diving to escape danger helps protect them from these land-based predators, but exposes them to other predators which include heron and pike.



Dive for survival Swimming and diving are the chief ways in which water voles can escape danger–and in these they are therefore expert although normally only use them as a method of escape. They swim, steer and dive using all four feet in a kind of dog-paddle. When scared, they dive to the bottom and stir up mud with their forefeet so that they are more difficult to spot. Voles can only hold their breath for about 20 seconds, so once they have dived they swim quickly to one of the underwater entrances to their burrow system.

Any swimming mammal has to keep its body surface as dry as possible so that it does not lose too much body heat. Water voles have a thick, warm layer of under-fur which traps air near the body surface; the warm air insulates the animal. The vole is further protected by long, greasy guard hairs, which project above the under-fur and so prevent it getting wet when the vole dives.

The home range If you see several water voles together, they are probably a family group, as they are generally unfriendly to other individuals. Both males and females have their own home ranges, which include a complex system of burrows. The ranges are marked and both males and females try to exclude other voles of the same sex as themselves.

Water voles mark the boundaries of their range in two ways: firstly, by the smell of their droppings, which are usually confined to the latrine sites at the edge of the range; and, secondly, by a scent that is produced by glands under the skin of the flank. The scent exudes on to the skin surface where it is transferred to the feet of the voles when they scratch themselves. From the feet, the scent reaches the ground and marks the voles' runways. Male voles have larger ranges to mark and so have bigger and more easily visible scent glands. The scent organ is located on each flank in the form of an oval of naked skin.

Voles' ranges vary greatly in size depending on the nature of the habitat. But Dr Michael Stoddart, in his detailed study of voles in Scotland, found that a male's range averaged 130m (142yd) of riverbank. He also discovered that the female range is only about half that length.

Males usually stay in their home range for the whole of their adult life. Females sometimes move to new areas, however, particularly when they are pregnant with the second or third litter in the breeding season.

Signs of activity Although water voles will dive for cover if disturbed, there are several signs you can look for. Burrows in the middle of a circular, grazed 'lawn'–usually of a radius of about 15-20cm (6-8in)–are caused

by voles staying in the mouth of the burrow while they feed. These are a good indication that voles have been at work. There may be several holes, or entrances, to the burrows; and while those are often below water level, you may well see some above.

Other signs are the piles of nibblings, which voles drop as they bite bits off a grass stem, or the white inner pith left in spring and summer from rushes. Voles droppings are usually made in special latrine sites at the extremity of their range. Each dropping is cylindrical, 10-12mm (about 0·4in) in length and khaki to light green in colour.

If you hear a rasping 'crick-crick' sound, it may well be a vole nearby that has been frightened. Otherwise, water voles are usually silent.

Although active both day and night, water voles are generally busiest by day. So if you watch quietly by a riverbank, where signs of voles are present, you may often be rewarded by a sighting.

Feeding Water voles are almost complete vegetarians, their main diet being the stems and leaves of grasses and other waterside plants. When they eat, they assume a characteristic hunch-backed stance, holding the food with their forepaws.

They do not usually feed more than 2m (6ft) from the water's edge, so that they can dive for cover if disturbed, and will often swim along or across the river from their home burrow to get to a feeding site.

Above: A female water vole with young in a disturbed nest. There are usually about five to each litter. The young are born naked, with eyes closed. At birth, they weigh about 5g ($\frac{1}{6}$oz), increasing by one gramme a day for the first week and slightly more in the second week. At five days, the young voles have fur; their eyes open after eight days.

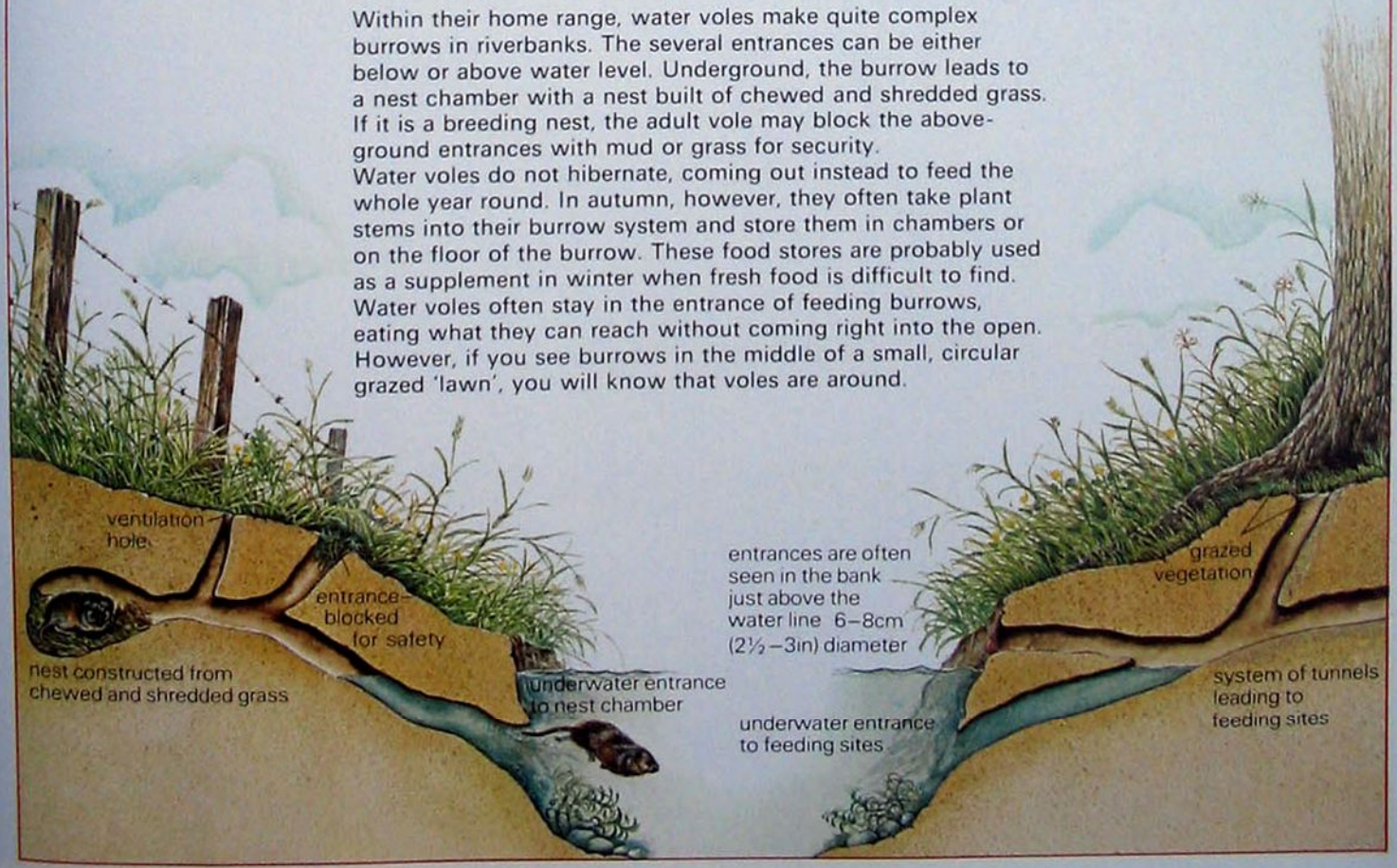
Breeding Water voles mate first in early spring, the first litter being born in April or May after a gestation period of three weeks. A female vole may have two or three litters in a summer.

The nests are usually made below ground in the burrow system, or at the base of rushes in marshlands. If the nest is disturbed when the babies are very young, the mother will carry them off, one by one, in her mouth, to a new nest site. By the time the young are two weeks old, they are weaned and within one month they are trying to establish home ranges of their own. By this time, the mother is likely to be pregnant with her next litter.

Water voles' riverbank home

Within their home range, water voles make quite complex burrows in riverbanks. The several entrances can be either below or above water level. Underground, the burrow leads to a nest chamber with a nest built of chewed and shredded grass. If it is a breeding nest, the adult vole may block the above-ground entrances with mud or grass for security.

Water voles do not hibernate, coming out instead to feed the whole year round. In autumn, however, they often take plant stems into their burrow system and store them in chambers or on the floor of the burrow. These food stores are probably used as a supplement in winter when fresh food is difficult to find. Water voles often stay in the entrance of feeding burrows, eating what they can reach without coming right into the open. However, if you see burrows in the middle of a small, circular grazed 'lawn', you will know that voles are around.


ventilation hole
entrance blocked for safety
nest constructed from chewed and shredded grass
underwater entrance to nest chamber
entrances are often seen in the bank just above the water line 6–8cm (2½–3in) diameter
underwater entrance to feeding sites
grazed vegetation
system of tunnels leading to feeding sites

A WALK THROUGH BURNHAM BEECHES

Despite its popularity as a recreation area, historic Burnham Beeches supports a rich array of plant and animal life. Many sights seen on this walk, such as the ancient pollards, are reminders of the forestry and rural life of centuries past.

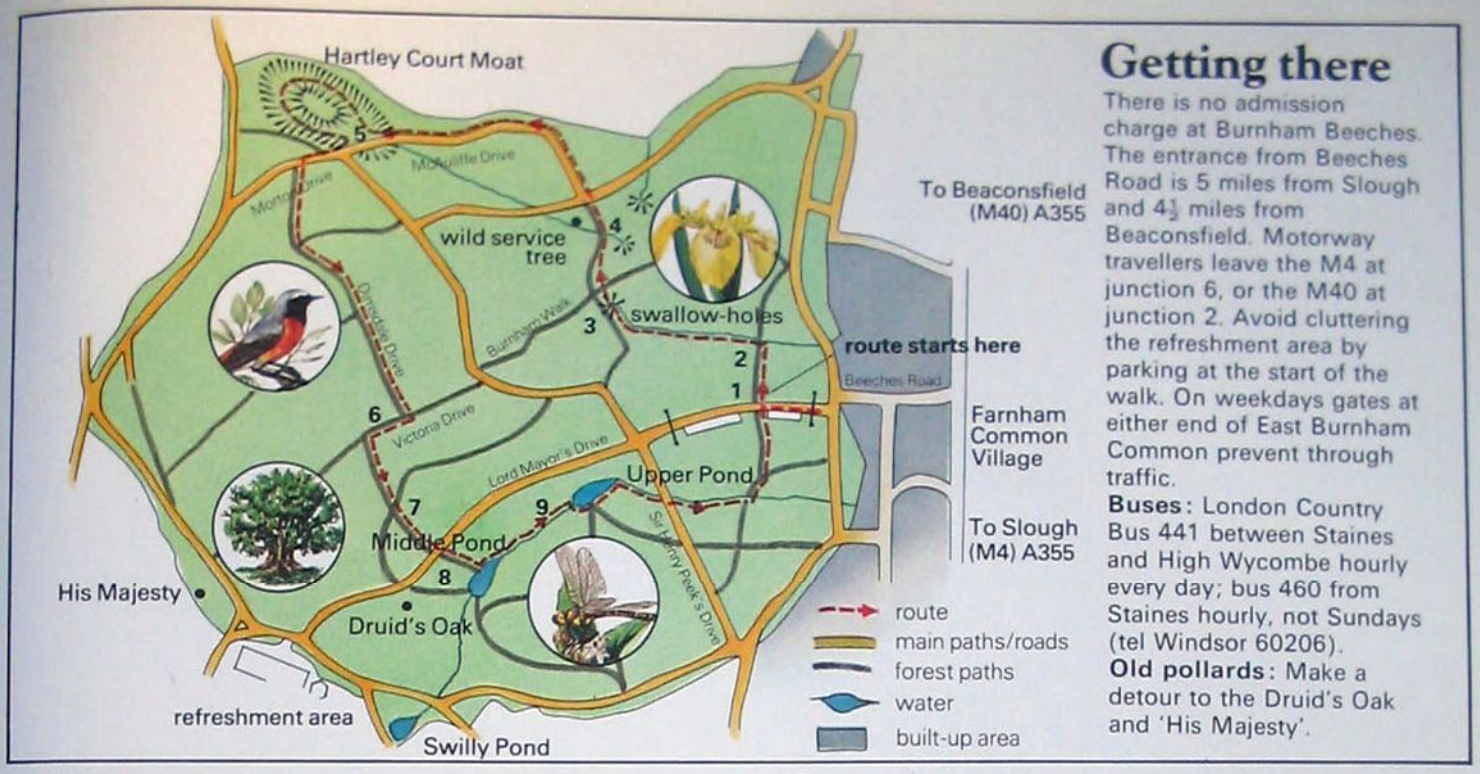
Below: October in Burnham Beeches. Many of the leaves have fallen and the woodland is now far better lit than in summer. Walkers should get better views of birds amid autumn's merging shades of green and golden brown.

On the western fringe of London, only a few miles from busy Slough and the M4, lies Burnham Beeches, a wild tract of woodland interspersed with grassy areas. It has survived the last 1000 years as uncultivated heath and woodland, being valued only as rather poor grazing land and a source of firewood.

As London expanded in Victorian times and people came to enjoy greater leisure, apathy turned to appreciation for the wild beauty of Burnham Beeches. The Corporation of the City of London purchased a large area in 1880, and today owns about 500 acres, maintaining it as a place of recreation for all. Walkers are often surprised to know that the cost of maintaining Burnham Beeches is paid entirely from the funds of the City and not a penny is charged to local rates or taxes.

Grassy clearing A good starting point is East Burnham Common, a large grassy clearing popular among devotees of ball games and picnics as well as of wildlife. We suggest you strike off to the north along the footpath which bisects the open area (**1**). On leaving East Burnham Common you pass through a fringe of gorse and birch into mature woodland of oak and beech.

Beech is often the dominant tree in southern woodlands on poor soils. It is a strong competitor, the seeds germinating readily and the young plants patiently tolerating the shade before they elbow their way up



Getting there

There is no admission charge at Burnham Beeches. The entrance from Beeches Road is 5 miles from Slough and 4½ miles from Beaconsfield. Motorway travellers leave the M4 at junction 6, or the M40 at junction 2. Avoid cluttering the refreshment area by parking at the start of the walk. On weekdays gates at either end of East Burnham Common prevent through traffic.

Buses: London Country Bus 441 between Staines and High Wycombe hourly every day; bus 460 from Staines hourly, not Sundays (tel Windsor 60206).

Old pollards: Make a detour to the Druid's Oak and 'His Majesty'.

through the canopy.

Beech pollards Frequently you will notice old, mis-shapen beeches with spreading branches coming off at a height of 2½-3m (8-10ft). These are overmature beech pollards (see page 82), of which Burnham Beeches is probably the world's largest collection. Their branches were lopped every few years as a source of firewood and to provide fresh 'browse' for cattle.

These trees, which are mostly over 300 years old, are slowly dying. Their demise may take a century or more, and in that time they will provide a home for a host of insects and other invertebrates. In a mature wood nearly half the insect species may be dependent on dead wood during their immature stages, and Burnham Beeches excels in the number of these species.

Woodland stream The path you have taken soon descends to a little stream (**2**). Turn left to follow its course. The vegetation on the woodland floor here is generally rather sparse, mainly because of the dense summer shade beneath the beech. Despite this, a number of plants grow there, such as herb robert, wood avens, cow wheat, hairy woodrush, wood melick and wavy hair-grass –all in the rather acid conditions created by the deep gravels and clays that lie over the chalk.

Along the stream you will come to an area where the vegetation is more lush and varied. Follow the course of the water and you find that it disappears, intriguingly, down a hole in the ground (**3**). This is one of three swallow-holes in Burnham Beeches. The stream continues underground through a passage which the water has carved in the chalk.

After heavy rain the flow of the stream can be too much for the subterranean passage, so it backs up, floods the area around the swallow-hole and lays down silt. The resulting deep soil supports a range of different plants – gipsy wort, hemlock water drop-wort, yellow flag, stinging nettle and the wild redcurrant grow in the wetter parts. Around the perimeter of the swallow-hole there is a range of typical woodland species such as sanicle, enchanter's nightshade, wood spurge, wood millet, yellow pimpernel and pignut.

The richness of this plant assemblage suggests that the site around the swallow-hole has supported woodland for centuries: such is the time required for so many woodland species to collect in one place. Further evidence is the great variety of shrubs and trees. Aspen, field maple, grey poplar, dogwood and guelder rose all appear in this small area.

There is something else to look out for here –animal tracks in the soft mud. Muntjac deer have become numerous at Burnham Beeches in recent years, but the shyer roe deer can be seen only occasionally.

Wild service tree From the swallow-hole, proceed over a slight rise across a path and follow the sound of running water to locate the second swallow-hole. This is rather more shaded and consequently has less luxuriant vegetation. Carry on up the course of this second stream to the Burnham Walk, where you turn right (**4**). As you come up the hill you will see a fine stand of tall beeches. A detour over to the left of the track should enable you to find one of Britain's rarest and most elegant trees, the wild service. A single specimen 30-40 years old stands proud over a new generation of several saplings and patches of seedlings.

Echoes from the past As you follow

Above: The jay buries stores of acorns and beech nuts among fallen leaves and twigs. If forgotten, these germinate, and the process is important for the spread of oak (beech spreads well enough without it).

Left: The beefsteak fungus grows on oak, which is common in Burnham Beeches despite the name. If picked young, the fungus is delicious when eaten in stews.

McAuliffe Drive uphill, the roadside displays a different selection of plants, some of them requiring more light and some indicative of disturbed ground. On the higher ground the soil is more acid, the vegetation changes and heather becomes more common. This is a remnant of the heathland vegetation of medieval times. In one area you may notice old oak coppice stools–oaks which were repeatedly cut back close to the ground every few years, perhaps to provide wood for charcoal. The last time they were coppiced is likely to have been before the First World War.

Hartley Court Moat (**5**) is the site of a moated farm believed to date from the 13th century. All signs of timber buildings have long since rotted away but the moat is still intact and holds water for most of the year. The vegetation here clearly reflects the acid soil, with plenty of heather and wavy hair-grass, and in the wetter places cross-leaved heath, purple moor-grass and hair moss.

Another feature of this area is the large nests of the wood-ant. Some of these are remarkable for being low but very wide–up to 2½m (8ft) across. A single nest may support over 100,000 workers, most of them busy foraging in the trees for insect prey to carry back to the nest.

Forest birds From Hartley Court Moat proceed along Morton Drive as far as the track known as Dimsdale Drive. Take this turning to the left and continue along the main path which winds its way steadily downhill. Notice on either side the variation in forest structure. There are fine old pollards on the higher ground, amid a high forest of beeches and oaks of various ages, with patches of birch where large trees have fallen or been removed.

Walk slowly and listen out for the sounds of many different birds. Commonest in summer will be the titmice–blue tits and great tits in the main but also marsh, coal and long-tailed tits. You should also hear or see chaffinches, robins, wrens, blackbirds, song thrushes, mistle thrushes, nuthatches and treecreepers. The summer visitors include willow warblers, chiffchaffs, blackcaps, garden warblers and the strikingly handsome but elusive redstart. Of larger birds you may see a woodcock, jay, great spotted or green woodpecker.

Turn right along Victoria Drive (**6**), then branch off to the left up a path which takes you over Seven Ways Plain (**7**). Beside the path are hollows where brickearth was quarried out of the hillside. You will also see a number of low banks and ditches, the remnants of prehistoric settlements. On reaching the Lord Mayor's Drive (**8**) go straight on until you encounter the Middle Pond.

The path follows the left bank of the stream (**9**) and crosses over at the Upper Pond. Wetland plants are plentiful here–bogbean, marsh pennywort, water pepper, water horsetail and bladderwort. On a fine summer's day you should also see many dragonflies and the smaller damselflies 'hawking' for small insects over the ponds.

Cross Sir Henry Peak's Drive and follow the stream before taking the path back to East Burnham Common.

Below: The Swilly Pond in its lush splendour. The peaceful atmosphere is in keeping with a site of its age: the pond was given its name in Anglo-Saxon times.

DEADLY SPINNERS

As summer begins to shade into autumn, hedges and banks become festooned with vertical, spirally-patterned webs made by orb web spiders. Each intricately woven web may display its fat-bodied occupant, clinging motionless and head down, waiting for prey to blunder into the trap.

In autumn orb web spiders reach full size and maturity, having spent the early part of the summer making ever larger webs as they themselves increase in size by shedding their outer skin (cuticle) whole. Their large September and October webs seem to appear overnight on almost every bush, bank, hedge, tuft of grass and group of flowers. If you can't find the spider itself sitting in the centre of its web, it will probably be lurking in its lair–perhaps a folded leaf to one side of the web–waiting for a victim.

The most familiar orb web builder–and one of Britain's largest spiders–is the garden cross, or diadem, spider, *(Araneus diadematus)*, so-called because of the white crucifix-like pattern on the top of the abdomen, the ground colour of which varies from pale brown to reddish-brown or sepia. Common in gardens, along thick hedgerows and in open woodland glades, the web occupants are generally females, with bodies as big as a large pea. Adult male diadem spiders, recognisable by their smaller, more triangular abdomen and prominent palps, or mouth 'fingers', are less often seen, since directly after maturing they abandon their webs and spend their short lives visiting those of the females, eating virtually nothing in the meantime.

Courtship and mating are carried out with extreme caution among diadem and other orb

The dew-spangled web of an orb web spider, *Araneus quadratus*, in the early morning. These webs can stretch to 60cm (2ft), or more across. The webs built by the young spiders are just as intricate as those of the adults, but it is generally only when they are seen at maximum size that their precision and regularity can be fully appreciated. The spider waits in the centre of the web for small insects to blunder in and get caught by the sticky threads.

Above: Diadem, or garden cross (*Araneus diadematus*) spiderlings in a group. As in many species of spider, it is likely that these spiderlings disperse far and wide with the help of wind currents, on which they are wafted at the end of long silk lifelines. Although many orb web spiders mature at the end of their first summer, some individuals, and some other species as well, probably take two years to reach full size. Many are caught before maturity by predators.

web spiders for the short-sighted female is liable to attack all intruders even when they happen to be one of her own species.

Once arrived at the perimeter of the female's web, the male announces his presence by tweaking an outer strand, at the same time providing himself with an escape-line of silk in case of repulse. He may be chased away fiercely several times before the female responds to the special vibrations induced by his web-pulling, and allows mating to occur.

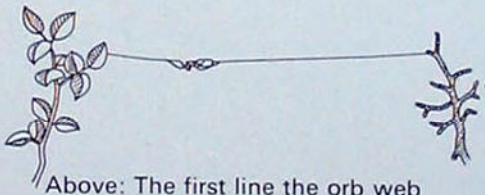
Mating itself takes place by means of the male's palps. Prior to the actual sexual encounter, the male discharges a quantity of sperm on to a special silk pad, then fills each of his palps, which act as reservoirs, with seminal fluid. Having temporarily subdued the female's aggressive tendencies, he then inserts first one and then the other palp into her genital aperture (epigyne), though he may have to retreat again after the first insertion. Mating over, the male retires, later seeking out another female. Many males, however, do not survive for more than one mating and either die of starvation or are killed by the female.

Egg-laying and hatching Some weeks after insemination, the female leaves her web and seeks out a hiding place where she produces a batch of several hundred eggs, which she covers with a double layer of yellowish silk. This cocoon may be fixed to the underside of a stone, beneath tree bark or perhaps in the corner of a garden shed. Here the eggs overwinter, hatching out the following May.

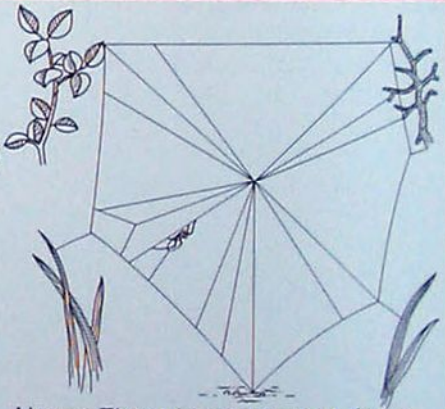
To start with, the spiderlings are very small, with abdomens scarcely as big as a pinhead, but they are distinctively coloured a rich yellow with a short bar of dark brown at the rear of the abdomen. The spiderlings occasionally attract attention by their habit of congregating in a tight ball on a base of silk. If you touch the ball with your finger, the little spiders scatter. The spiderlings remain in their ball until their next skin change, then disperse to make small individual webs of their own. Each spider may come to maturity at the end of its first summer but more usually

Construction of an orb web

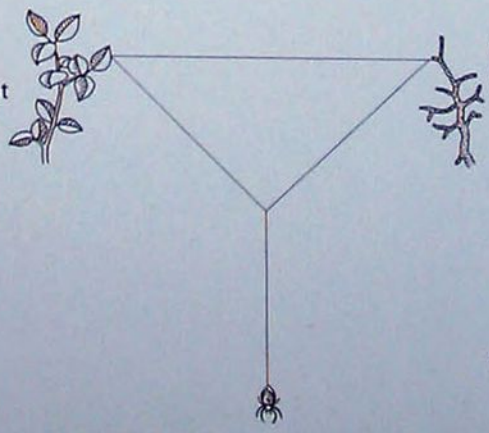
All orb web spiders begin their web with a horizontal bridge line. A thread is secured at one end while the other is allowed to waft across a space until it adheres to a twig or leaf; the spider strengthens this bridge by passing over it several times, laying down more silk. Next the spider passes from one end of the bridge to the other, dragging a loose thread and fixing it at both ends. It then returns to the centre of this thread and descends on a further line which, after being pulled taut, is fixed to an outer point. The spider has now created the first three web radii and one frame segment in the form of a closed letter Y, the centre of the Y forming the web's centre. Further frame lines are added so as to make a multi-sided frame. By repeated climbing and dropping, further radii (up to about 40 in all) are constructed. The central hub, where the spider sits, is then completed, and an inner strengthening spiral added. Now, leaving a gap, the spider constructs the main outer web spiralling, using radii as footholds (but only as a temporary measure). Finally, the spider goes over the main spirals again, destroying them as it goes and replacing them with gum-coated lines that will secure the prey. Oil on the spider's feet prevent it being caught in its own web.



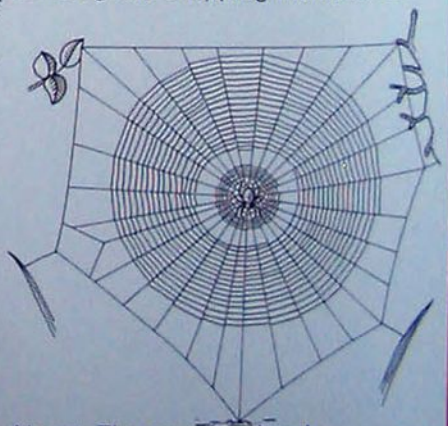
Above: The first line the orb web spider makes is a horizontal bridge secured at both ends and strengthened by silk strands.



Above: The spider adds more frame lines and radii by a series of climbing and dropping manoeuvres.



Above: This closed letter Y, formed by the spider descending on a loose thread, establishes the centre of the web and one frame segment.



Above: The completed web.

Some orb web spiders

Araneus diadematus

Zygiella x-notata

Tetragnatha montana

Meta segmentata

takes another year dying soon after its own mating and egg-laying. However, this probably depends partly on the weather and the food supply.

Trapping prey in the web Spiders usually construct their webs in the evening or the early hours of the morning, commonly positioning them only 30-60cm (1-2ft) from the ground and at vantage points instinctively chosen to secure a steady stream of prey. In gardens they take a heavy toll of insects such as craneflies and daddy-long-legs whose low, blundering flight renders them especially prone to ensnarement. A wide variety of prey is taken, from small flies to grasshoppers, but the more violent or unpleasant tasting infiltrators are generally cut loose.

Only the larger, outer spirals of the orb web spider's web are sticky (viscid) and it is this region which traps the blundering insects. If the spider is lurking in its lair, it is given immediate notice of the victim's arrival by means of a line of silk connected to the web, which the spider holds in its forelegs. The spider then dashes across the web to bite the prey, injecting it with venom which also contains a digestive enzyme to break down the insect's tissues into liquid form, which the spider drinks. At the same time the spider swathes the captive in silk so it is powerless and can be stored for future use.

Despite its apparent delicacy, the spider's silk is remarkably strong and elastic. It is produced by six spinnerets, special organs situated at the hind end of the abdomen, each of which exudes silk in multiple strands that, by chemical reaction, coalesce and solidify as one as they leave the body.

The role of spiders in controlling the insect population is significant, but spiders themselves are not without enemies. Birds take toll of them, and many spiders are preyed on by robber-flies, ichneumons and hunting wasps as well as other spiders.

Some garden species Garden spiders belong to the family Argiopidae, of which there are about 40 species in Britain. All of them make orb webs, but few are as large and conspicuous as the diadem spider. One of the more secretive species is the rather sinister-looking *Araneus umbraticus*, which builds its web on old trees and outbuildings. Mottled brown or near black, with a subdued crenellated pattern on its flat and somewhat dimpled abdomen, this spider spends most of the daylight hours in a crevice near its web, emerging at night to kill and collect prey. This spider hibernates in winter. *Araneus quadratus* is another large, related species, commoner on heathland in northern England. Its variably coloured abdomen bears a dotted pattern in the rough form of a rectangle.

Many other orb web spiders are much smaller, notably those of the genus *Meta*. *Meta segmentata* is a typical example. Often spinning on low vegetation in gardens, its web has a clear space in the centre and is usually set at a slight angle to the ground. Equally distinctive are the webs spun by the two commoner species of *Zygiella*. Each is identifiable by the omission of spiralling from two upper segments of the web.

Above: Some garden-dwelling orb web spiders; these are all females. *Tetragnatha montana* belongs to the Tetragnathidae family, not the Argiopidae like the others; its web is made of such fine silk that it is difficult to see it at all.

Below: Female *Araneus diadematus* with prey wrapped securely in silk. The spider revolves the victim in its legs, swathing it with strand after strand of silk until it is absolutely helpless.

BRACKEN: BEAUTIFUL BUT FATAL

Hillsides covered with golden bracken look marvellous in the autumn sun. But this species is a bane to farmers, causing disease and even death to livestock.

To a modern hill farmer, bracken is a formidable enemy. It spreads by means of long underground stems (rhizomes) that make it almost impossible to eradicate, and it contains several chemicals that are highly poisonous to horses and cattle.

Bracken is one of the most common plant species on heaths and uplands. It has been estimated that it grows over about one and a half million acres in the British Isles – about 10% of our total hill country, and when it is well established it covers the land completely.

Bracken is a tall, broad fern and, like other ferns, it grows larger and more luxuriant in sheltered shady places. The spore-bearing sori form a continuous line beneath the margins of the pinnules, and millions of spores are produced each year. The life cycle is similar to that of the male fern (see page 265), but the mature fern does not form tufts of fronds (crowns). Instead the fronds sprout at intervals from the rhizomes that creep in the soil.

Vigorous colonizer It was almost certainly man's influence that led to the spread of bracken, transforming it into a serious pest. In pre-Neolithic times when the British Isles was covered by forests bracken grew with other plant species in the forest undergrowth. As Neolithic man cleared the forests and more of the land was used for primitive agriculture, bracken spread into the newly opened areas and quickly invaded any abandoned arable land. Bracken still grows in woodlands all over the country, but it rarely dominates them as it does in more open places.

During medieval times bracken was apparently held in check for it was cut and used for a variety of purposes. Cutting provides a good method of control, especially if done in midsummer, for the vigour of the plant is then impaired. Late summer cutting leaves the plant susceptible to frost.

In the 18th and 19th centuries bracken began to spread once again. At that time many upland farmers started to keep sheep instead of cattle, as had been their previous practice. Cattle feed on some of the young shoots, damage others with their heavy hooves, and crush mature fronds with their weight. But by contrast sheep avoid eating bracken and, as they are so much lighter than cows, they do not cause the same amount of damage to the fronds. Bracken therefore had an opportunity to become well-established.

During that period many upland areas suffered from depopulation as people migrated to the cities, where the industrial revolution was dramatically changing the lifestyle of the country. The arable land that had once been farmed provided an excellent environment for bracken – and rabbits. These animals, like sheep, do not eat bracken but feed on other plants that live in similar habitats. This eliminates potential com-

Above: In autumn bracken turns a beautiful shade of golden brown. It is a pioneer species, and quickly invades uncultivated land. Indeed, its name is thought to be derived from the German words *Brache* or *Brachfeld*, meaning uncultivated land. Medieval people used bracken as bedding for livestock, as a source of potash in the manufacture of soap and glass, in treating wool for dyeing, in medicine, as a fuel and as a compost.

petitors and enables the bracken to spread even faster.

Depopulation of upland areas allowed the spread of bracken in other ways too. As long as people lived close to the land they could inspect it regularly and eliminate perennial weeds, such as bracken, before they became properly established.

Lack of inspection of marginal land has led to a renewed expansion of bracken during the first half of the 20th century when, during the world wars, labour was scarce and food production took priority. Many scientists think that the exceptionally warm weather during this time also contributed to the spread of the plant, since its susceptibility to frost ensures that it does not spread in cold periods. Spore counts from archaeological digs usually show an increase in bracken pollen in warm periods and a decrease in cold intervals.

Livestock killer Bracken continues its underground spread today and scientists and farmers are actively seeking ways to prevent further contamination of grazing land by this species. The problem is that bracken is highly poisonous to cattle and horses, causing a disease known as staggers. This comes from the presence of an enzyme in the plant which destroys thiamine (vitamin B_1) in the animals that eat the fern. The symptoms include a lack of co-ordination in the affected animal, convulsions, and eventually death. Once it is realised that the disease is directly due to a lack of thiamine, then steps can be taken to treat the affected animal.

There are other poisons in bracken which cause even more dangerous symptoms, especially in cattle. Recent research has shown that there are powerful carcinogens in the plant which may damage the bone marrow and intestines of cattle. These cancer-inducing chemicals can also affect man: in Japan, the eating of young bracken fronds–considered a delicacy–has been linked with stomach cancer.

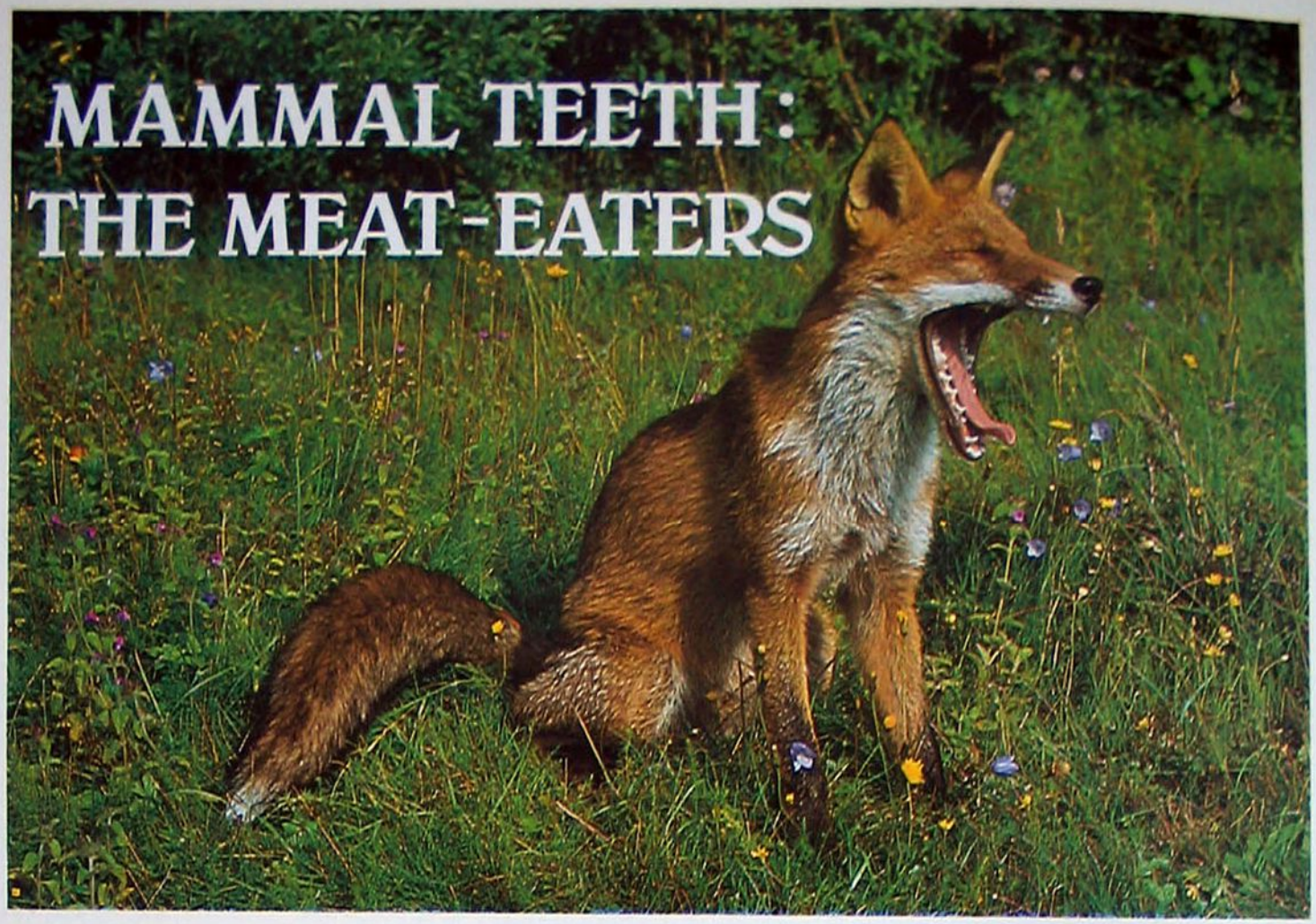
If our livestock are to avoid bracken poisoning, then the ever increasing spread of this fern into our farm grazing land must be halted. Perhaps they had the right answer in the Middle Ages when they continually cut the plants and used them for numerous purposes. If we found a use for this species then it would be harvested regularly, and this would help enormously in the fight for its control.

Above: These young bracken fronds have sprung up just three weeks after a fire had burnt the vegetation to the ground.

Below: **Bracken** (*Pteridium aquilinum*) is common in woods, on heaths and grassland on acid soils, absent from limestone areas. Very common, spreads fast. Fronds may be up to 2m (6ft) long.

young fern with curled frond (crozier)
pinnules
underground stem (rhizome) may stretch for several metres, sending up new fronds at intervals

MAMMAL TEETH: THE MEAT-EATERS



Usually known as carnivores, meat-eating mammals have sharp teeth with prominent canines – the fangs – and cheek teeth that are designed for slicing meat and grinding bones.

Teeth are incredibly hard and strong – they have to be to stand up to a lifetime of biting and chewing. The shape and size of a tooth depends on which part of a mammal's mouth it comes from and on the type of food the mammal eats. The mammals that kill other animals and eat flesh and bones are known as carnivores and, in Britain, include members of the dog, weasel and cat families. Moles, hedgehogs, shrews and bats eat insects and are called insectivores. The herbivores, those that eat plants, are described later.

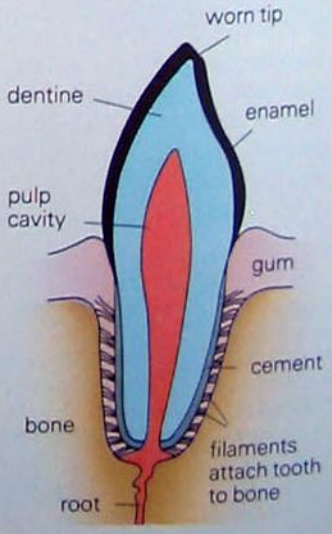
Mammals have two sets of teeth: milk teeth (while the mammal is young), and the adult set. The milk teeth are used during the weaning period while the young mammal is starting to eat solid food. In almost all species of mammals, the milk teeth are like smaller versions of the adult incisors, canines and premolars. There are no milk molars, but the adult molars appear before all the milk teeth have been lost The various types of adult teeth are specialized for the different processes of biting and chewing.

Structure The pearly white enamel, which covers the outside of the tooth, is composed of 96% mineral salts for maximum hardness. Tooth enamel is the hardest substance produced in the body of mammals. Inside the enamel layer, most of the tooth is dentine which is very like bone in structure, but harder. Unlike bone, dentine which has finished growing has no living cell bodies inside it. The living part of the tooth is a pulp-filled cavity, containing the blood vessels and nerves which keep the tooth alive. The tooth is fixed in its socket by a root held firm by a modified form of bone called cement.

The fox has four canine teeth which are the largest and most obvious of its 42 teeth. Canines are used for attack by all carnivores, and for defence against attack by larger animals. In front of the canine teeth are the smaller incisors. All true carnivores have 12 incisors, six in the top jaw and six in the bottom. The incisors are used for nibbling small pieces of meat off a bone, and for grooming. Behind the canines are the cheek teeth. The ones immediately behind the canines are the premolars and those right at the back of the mouth are the molars. Front teeth are for biting and nibbling, cheek teeth mainly for cutting and chewing.

All the true carnivores (members of the dog, weasel and cat families) have two cheek teeth, the carnassials, on each side of the

The fox (above) has 42 teeth, of which the canines are its main weapon of attack. When a fox pounces on a rabbit, the canines bite through its neck or the back of its head. Like the front teeth of all mammals, the canine (below) has only one point (cusp) and only one root.



mouth, which are enlarged and modified for cutting through meat or bones. In the top jaw the hindmost of the premolars is large, three-pointed and flattened on the inner surface. It works against the first of the premolars in the lower jaw, this tooth being large and flattened on the outer surface. When a fox closes its jaws the flattened surfaces of the upper and lower carnassials shear across each other in a very effective cutting action. It is to bring their carnassials into action, that foxes and dogs, and other carnivores, chew at meat with the sides of the mouth.

Although the fox is a meat-eater, it is also a scavenger and general feeder (an omnivore). This is one reason why there are a large number of molars and premolars–some for biting, others for chewing or crushing insects.

A mole has 44 teeth, all of which are sharp-pointed for catching and holding worms. Moles are fierce territorial animals and use their enlarged upper canines for fighting. Moles are unusual in not having any proper milk teeth.

Hedgehogs have slightly fewer teeth than moles, but all the teeth are pointed for eating invertebrates. Their milk teeth start to be replaced when the hedgehog is nearly four weeks old.

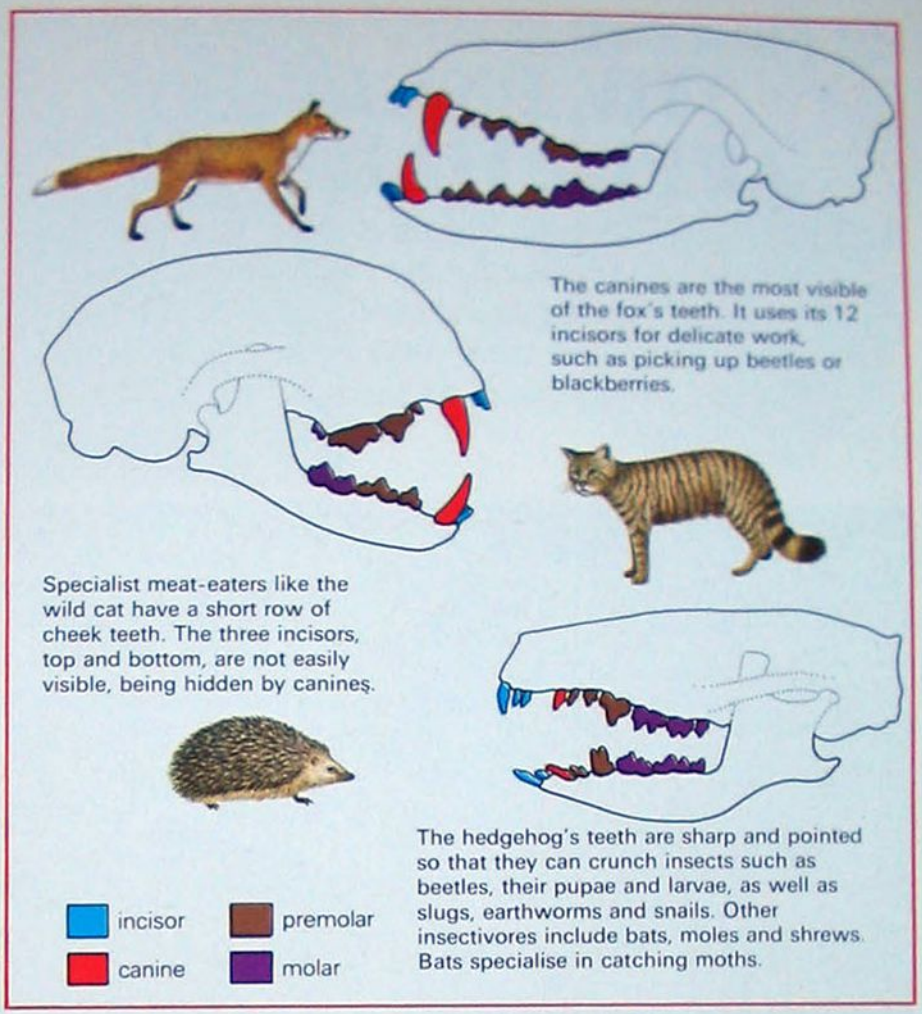
Shrews' teeth are adapted for eating insects. The very large front teeth, top and bottom, project beyond the jaw and enable shrews to pick up small insects. The cheek teeth are many-pointed; some of them are wide and are used for crunching tough chitin-covered insects.

Bats crunch insects, too, and their cheek teeth are very similar to those of shrews. The pointed incisors and canines help hold and kill insects. Baby bats have small milk teeth which drop out shortly after birth. They may be used for clinging on to the mother's fur.

Telling mammals by their teeth Each species of adult mammal has a fixed number of teeth of each type, whether they are incisors, canines, premolars or molars. If you find the skull of a dead mammal in the countryside, the numbers and types of teeth are the best guide to identify the species. The simplest way of noting the numbers and types is to count the teeth on one side of the jaw only (there should be exactly the same number on the other side) and to write the numbers down in a standard way, called the dental formula. The top row of figures in the examples below gives the number of teeth of one side of the upper jaw, while the lower row of figures represents one side of the lower jaw.

Fox	$I\frac{3}{3}$	$C\frac{1}{1}$	$PM\frac{4}{4}$	$M\frac{2}{3}$
Hedgehog	$I\frac{3}{2}$	$C\frac{1}{1}$	$PM\frac{3}{3}$	$M\frac{3}{3}$
Mole	$I\frac{3}{3}$	$C\frac{1}{1}$	$PM\frac{4}{4}$	$M\frac{3}{3}$
Weasel	$I\frac{3}{3}$	$C\frac{1}{1}$	$PM\frac{3}{3}$	$M\frac{1}{1}$
Wild cat	$I\frac{3}{3}$	$C\frac{1}{1}$	$PM\frac{3}{2}$	$M\frac{1}{1}$

I incisors **C** canines **PM** premolars **M** molars


The canines are the most visible of the fox's teeth. It uses its 12 incisors for delicate work, such as picking up beetles or blackberries.
Specialist meat-eaters like the wild cat have a short row of cheek teeth. The three incisors, top and bottom, are not easily visible, being hidden by canines.
The hedgehog's teeth are sharp and pointed so that they can crunch insects such as beetles, their pupae and larvae, as well as slugs, earthworms and snails. Other insectivores include bats, moles and shrews. Bats specialise in catching moths.
incisor
premolar
canine
molar

Right: With wide open mouth, the bat can catch insects in flight. The large gap between the left and right upper incisors may help the bat direct its echo-location ultrasonic squeaks–the sounds that it uses to navigate.

Below: The mole has more teeth than any other mammal in Britain. All its teeth are sharp-pointed: a bite will paralyse a worm, so that it can be stored until the mole is hungry.

THE ENGLISH APPLE HARVEST

Although Cox's Orange Pippin (below) and Bramley's Seedling are deservedly the most popular and successful of our apples, there are numerous other varieties, each with their own special qualities of flavour, appearance, texture and shelf life.

'No fruit is more to our English taste than the apple', E. A. Bunyard a famous authority on fruit-growing declared. It is undoubtedly true that the apple is the most typically British fruit, compared with, say, pears, peaches and cherries, all of which have a touch of the exotic about them.

A successful commercial apple must be heavy cropping and reasonably resistant to the more serious pests and diseases. It must store well and withstand rough handling. Most importantly, apples must have consumer appeal and look attractive in the shops. Dessert apples need a good flavour and texture, and cooking apples must have acceptable culinary qualities.

COOKING APPLES

Above: **Lane's Prince Albert** is a popular garden variety. Pick late Sept, season Nov-Jan, will keep until Feb.

Above: **Grenadier** is the best commercial early cooker. Pick mid-Aug onwards, will not keep beyond Oct.

All these stringent requirements mean that out of the many hundreds of varieties available only a limited number are grown commercially. This narrowing of the selection is inevitable, but a pity, because it means that a number of delicious varieties such as Ashmead's Kernel, D'Arcy Spice, Orleans Reinette, St Edmund's Russet, Sunset and Laxton's Fortune, to name just a few, are seldom found in the greengrocer's or supermarket. You occasionally see these varieties in farm shops, but generally they are only grown in gardens. This does not mean that commercially grown varieties are tasteless–far from it: Cox's Orange Pippin will always be ranked as a superb dessert variety, and Bramley's Seedling is usually thought to be the best cooking apple in the world. These two varieties between them occupy the bulk of the commercial acreage.

Above: Bramley's Seedling is the most widely grown and successful cooking apple in the British Isles.

Below: **Newton Wonder** is still a good garden apple but no longer grown commercially. Pick early Oct, will keep until April.

The apple harvest stretches from July to November, with the main activity in September and early October. The early cooking varieties are the first to be picked. They are not ripe in the purest sense, but they are large enough to be cooked, in late July. The sugar added during cooking compensates for the absence of natural sugars which would develop during ripening.

There are no hard and fast rules separating cookers from eaters. Some varieties, such as Newton Wonder and Monarch, are used mainly for cooking but can also be eaten and enjoyed as they ripen by those who prefer sharp tasting fruits. Conversely James Grieve, an attractive dessert apple when ripe, can be used for cooking as soon as it becomes large enough.

Chemically, ripe dessert varieties are relatively high in sugars, while good cookers contain more acids. A variety both rich in sugars and high in natural acids has that special quality–flavour, and Cox is the outstanding example of an apple with this combination.

Where do the varieties come from? It is easy to raise a new variety of apple. All you have to do is sow some pips from the next one you eat and raise a seedling to the fruiting stage, and you have a new variety,

Right: **Bramley's Seedling** is the heaviest cropper. Pick early Oct, will keep until Jan, or May in cold store.

Where the apples are grown

	Dessert	Cooking
South-east	26,328	14,717
Eastern counties	13,382	4,917
West Midlands	4,524	1,391
South-west	1,992	593
Remaining regions	294	245
Total in acres	**46,520**	**21,863**

EATING

Right: **Discovery** is attractive and a comparative newcomer. Pick late-Aug and eat at once, does not keep.

Right: **Egremont Russet** is good to eat in Oct and Nov. Fine flavour. Pick end Sept.

Cox's Orange Pippin is our most successful dessert apple. Pick late Sept, eat Oct onwards. Superb flavour.

which you can name after yourself if you wish. But apples do not breed true from seeds and the chances of the new variety being equal to, or even better than, existing ones are slim.

However, over the years, gifted and green-fingered amateurs have raised superb new varieties, a feat best typified by Mr Cox, a retired brewer from Slough, who in 1825 sowed some pips from a fruit of Ribston Pippin, and produced his unique Orange Pippin.

Most worthwhile new varieties today come about as the result of work by plant breeders at the research stations, particularly those at East Malling in Kent and Long Ashton near Bristol. East Malling has recently produced Suntan and Kent, while workers at Long Ashton are concentrating on treating existing varieties with irradiation to induce mutations, a number of which look promising. Other mutations from existing varieties have been planted because they have brighter coloured skins and therefore higher consumer appeal.

Although most of our apple varieties are home produced, there are some popular foreign ones, such as Golden Delicious from America, which has transformed apple growing on the European mainland and is now planted on a smaller scale in the British Isles.

Whatever the origin of a new variety it is usually first tested at the Ministry of Agriculture's National Fruit Trials at Brogdale in Kent.

Above: **Laxton's Fortune** is less common than it used to be. Well flavoured, mid-season variety, but bruises easily. Pick Sept, eat Oct.

Cookers Picking begins in July with Early Victoria, known in some areas as Emneth Early. The fruits swell quickly, encouraged by the farmer who prunes the trees severely in winter to reduce the number of blossom buds, then thins out the surplus fruits as soon as they set so that the energies of the tree are concentrated on a relatively small number of fruits. Grenadier follows, filling the gap until the main and dual purpose cookers take over. The major cooking apple is Bramley's Seedling, raised in Nottinghamshire in 1876 and still being planted in large quantities today. Apart from its outstanding cooking quality, Bramley has a long storage life, especially in controlled atmosphere storage, and it can be found on the market until May.

Early Victoria, Grenadier and Bramley constitute the great bulk of supplies of culinary apples, but others can be found locally, including Lord Derby and Lane's Prince Albert, both reliable varieties but in the second rank in commercial terms. Arthur Turner is worth growing for the sake of its flowers alone, and Howgate Wonder produces very large fruits.

Eaters The first dessert apple to reach the shops in any quantity is a relative newcomer, Discovery, a bright red fruit of good quality, which is picked from August onwards. Towards the end of the month the red and juicy Tydeman's Early appears. It is a cross

Above: **Laxton's Superb** is a heavy cropping, long keeping eater. Pick early Oct, keeps until March.

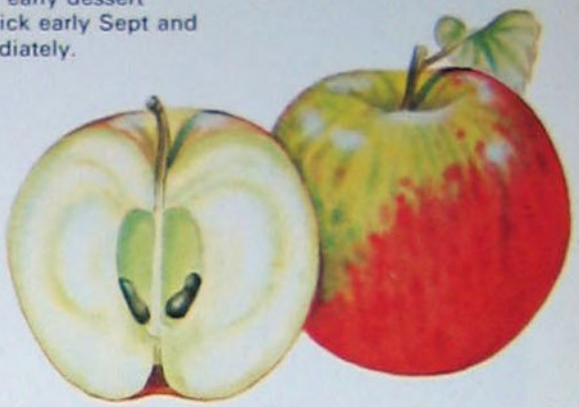
Below: **Golden Delicious**, heavy cropping and pleasantly flavoured when fully ripe. Pick Oct, long keeping.

Above: **James Grieve** grows well in northern England, Scotland. Juicy, good flavour. Pick Sept.

APPLES

Left: **Tydeman's Early Worcester** is a good flavoured early dessert variety. Pick early Sept and eat immediately.

Left: **Crispin** is a late ripening, long keeping dessert variety recently introduced from Japan. Pick Oct.



between Worcester Pearmain and an American variety. The long-established Worcester follows soon afterwards; at one time there was a tendency to pick Worcester too early, but it has a good flavour if picked when ripe. By September James Grieve, a very pleasant apple, should be ready. You often see it among Cox orchards where it is planted as a pollinator (see page 175).

Egremont Russet is one of the best of the russet skinned varieties which are generally crisp and well flavoured. It keeps well, even out of store, and can be eaten over a long period. Cox's Orange Pippin is picked towards the end of September and is ready for eating from October onwards. Most of the Cox harvest goes into store, and the modern fruit grower can control both temperature and atmosphere so that the apples keep in good condition until spring if necessary. Cox varies a good deal in skin colour, according to soil, season and state of maturity.

Laxton's Superb was bred from Cox, and it looks similar, although it keeps longer. Spartan is a new, increasingly popular variety. Crispin, bred from a Japanese variety and Idared are two new varieties that can be kept for a long time, perhaps until the start of next season's harvest, thus providing the possibility, when supplies are sufficient and markets stable, of English apples being available all year round.

Above: **Worcester Pearmain** is the most popular early eating apple. Pick early Sept when fully coloured, eat by Oct.

Below: Egremont Russet apples have firm, pale yellow flesh and a delicious flavour. They can be cold stored until Christmas. Russet apples as a whole are well flavoured and go well with port.

Above: *Oniscus asellus*, and two of the lighter coloured *Porcellio scaber*. Woodlice are not actually lice at all; they have many local names, such as tiggy hogs, God's little pigs, and sowbugs.

WOODLICE: ARMOURED INVERTEBRATES

Woodlice are crustaceans, related to crabs and lobsters, and have been living on dry land for 50 million years. Only crabs have made similar headway on land – and then only as far as the shore because they must return to the water to breed, whereas woodlice are fully adapted to a terrestrial existence.

Woodlice are recognisable by their seven pairs of legs, which are attached to the main part of the body. The head has eyes, a pair of antennae, and mouthparts for biting and chewing. At the rear end of the body is a short section with special limbs used in respiration and (in the male) for sperm transfer during mating.

Woodlice are isopods, which are a major group of crustaceans; in basic structure they resemble marine isopods such as the gribble, which bores into wood, and *Idotea*, which lives among seaweed. Marine isopods are found well back in the fossil record, but terrestrial species appear to be relatively recent (50 million years old!). It is thought that when they moved on to the land, they lived at first on the seashore, where a number of species still remain, including the sea slater (see illustration).

Eggs in a pouch Woodlice mate when the male mounts the female and transfers sperm using his modified rear limbs. By twisting his body first to one side and then the other, he places sperm in the genital openings on her underside. Once fertilised, the eggs are laid into a brood pouch filled with liquid, forming a false 'floor' under the main part of the body.

In this protected environment the embryos develop and then hatch, but the young remain in the pouch until they are well formed,

Protective armour
Some woodlice are flattened with the heavily armoured top surface hiding the legs when looked at from above. Pill bugs are rounded and can roll up into a ball for protection (see below). Other woodlice have long legs and rely on running speed to avoid capture.

resembling miniature adults. In this way woodlice protect the early developing stages of their young from the worst rigours of the terrestrial environment. The number of eggs produced varies between species, and is also related to adult size, ranging from 4-5 in the small species to 300 or more in large adults of the largest species.

It takes between three months and two years for the young to reach maturity–depending on species and locality. Growth takes place during the warmer months of the year only, although woodlice remain active all year round. A few species have only one brood a year, but most manage a second brood in the autumn. Maximum life span is four years (in the common pill bug, *Armadillidium vulgare*) but usually it is no more than two years.

Mixed diet Woodlice eat decaying matter of all kinds, with leaf litter being the staple diet. This is eaten in large quantities, and woodlice in many habitats are key members of the community that breaks down dead plant material and return nutrients to the soil. Fungi, green algae growing on tree trunks, and carrion are consumed as well. Woodlice are unable to absorb all the essential nutrients from their food the first time it passes through their gut, so they eat their own faeces. The bacteria in these breaks down the food sufficiently during its second journey through the digestive system to release the nutrients.

Woodlice even eat each other. Such cannibalism is rare in the wild, but can be seen if woodlice are kept in captivity in large numbers. It is usually moulting or moribund animals which suffer. Woodlice which get into greenhouses can be a nuisance because they eat succulent young seedlings, particularly marrows and cucumbers.

A meal for others Predators of woodlice were once thought to be few, because of the distasteful and sticky fluids that woodlice can discharge from glands along the sides and rear of the body. However, recent research has shown that they are taken in large numbers by centipedes, spiders and beetles; while little owls, toads and shrews also eat them readily. Any that die from other causes are rapidly scavenged by ants.

Well-developed behaviour Woodlice, unlike insects, do not have a waterproof cuticle and their chief problem on land is water loss. They have largely overcome this by developing a set of behavioural responses that make them instinctively come to rest in damp, dark and confined places. For instance, they move away from light, and they move more slowly the greater the humidity. The intensity of these responses varies with the degree of water stress experienced, and is reversed if an excess of water builds up in the body. Furthermore, response varies on a 24-hour basis, to allow escape from shelter sites at night to find food and mates (conditions in the open at night are generally much more humid than in the day).

Where to find them Woodlice occur almost everywhere in the British Isles and are usually more abundant in forests and ungrazed grassland where there is plenty of leaf litter and shelter. Densities of 500 per square metre are quite common. However, many woodlice require large amounts of calcium to make up the calcium carbonate which strengthens their hard outer surface (exoskeleton). So they are most abundant on calcareous soils. Most species are a good deal less common in the north than elsewhere because of the prevalence of acid soils which they do not like.

Above: *Oniscus asellus* shedding its exoskeleton. Woodlice grow continuously in life and, as with other crustaceans, insects and spiders, they have a hard outer surface (exoskeleton) which they must moult at intervals. They are unique, however, in moulting in two halves: the rear half of the body is shed several days before the front half. This ensures some mobility during this critical time, and so minimises the dangers from predators.

Facts about woodlice

There are currently 46 species of woodlice found in Britain but only 32 are likely to be seen away from greenhouses, and so can be regarded as native. One species, *Metatrich niscoides*, has just been discovered and is unknown outside Britain. Our largest woodlouse, *Ligia oceanica*, is 3cm ($1\frac{1}{4}$in) long, while the smallest, *Trichoniscus pygmaeus*, is 2·5mm ($\frac{1}{10}$in).

Sea slater (*Ligia oceanica*) 25mm (1in) long. Around coasts.

Philoscia muscorum 11mm ($\frac{3}{8}$in) long. Common, in hedgerows, grass, except in N England and Scotland.

Trichoniscus pusillus Up to 5mm ($\frac{1}{8}$in) long. Common, wide range of habitats.

Oniscus asellus 16mm ($\frac{3}{8}$in) long. Widespread, on damp rotting wood.

Porcellio scaber 17mm ($\frac{3}{4}$in) long. Widespread, in dry places, sand dunes, walls and gardens.

Common pill bug (*Armadillidium vulgare*), 18mm ($\frac{3}{4}$in) long. Widespread.

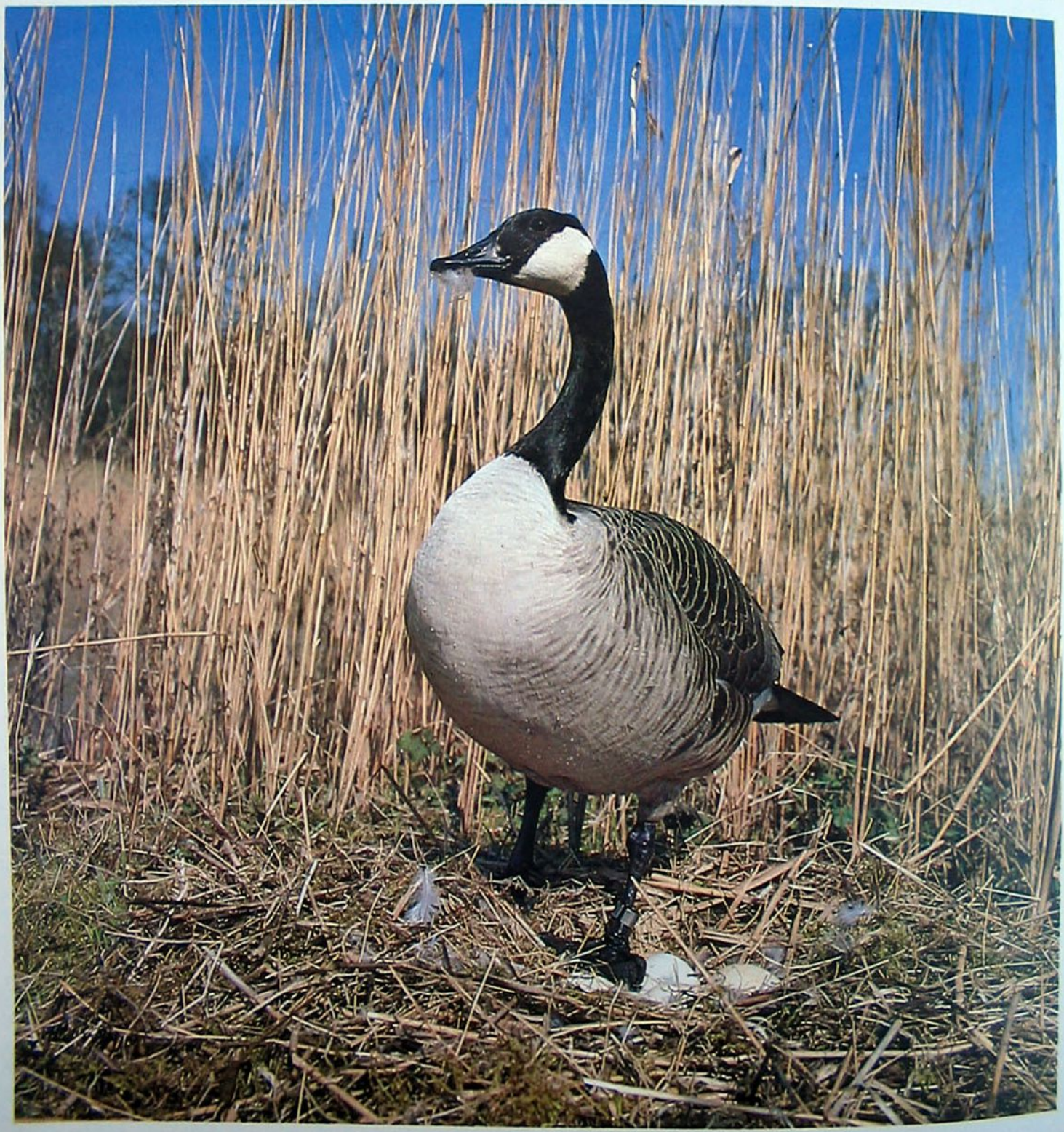
GEESE: MIGRANTS FROM EAST & WEST

Brent and barnacle geese visit various coastal sites of the British Isles in winter, after breeding in separate areas in the Arctic Circle. Canada geese (below) are mainly resident here, though they were originally introduced from America 200 years ago.

The Brent Goose, the smallest goose species, is not much bigger than a large duck. It has a circumpolar distribution and breeds on coastal tundra and small islands in the high Arctic. Over thousands of years, separate populations have evolved plumage differences – with underparts ranging from dark grey to silvery white – sufficient for them to be described as sub-species.

Breeding and migration The dark-bellied Brent Geese have dark grey underparts and breed in northern Siberia. These birds migrate to north-west Europe for the winter, living in estuaries in eastern and southern England, the Netherlands and France.

There are also three separate populations

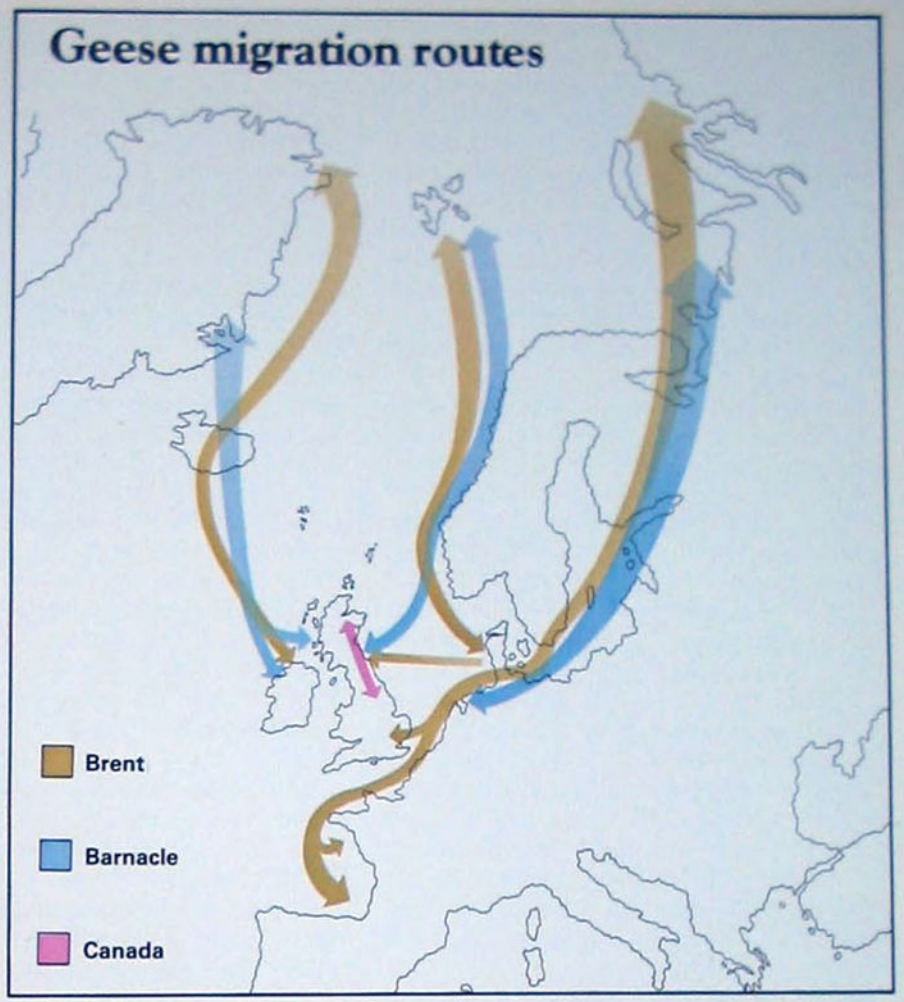


of light-bellied Brent Geese, which have silvery-grey underparts. The largest, numbering about 100,000, breeds in eastern Arctic Canada and winters on the east coast of the United States. A second population of about 9000 birds, breeds in the very north-east of Arctic Canada and northern Greenland, and winters in Ireland. The smallest population, of under 3000 birds, breeds in Spitsbergen and winters in Denmark.

Arctic breeders Brent Geese breed in the far north, almost all of them well north of the Arctic Circle. Here the brief summer is only just long enough for them to complete the breeding cycle. Indeed, in order that the young are on the wing before the cold of winter returns in September, the eggs are often laid while the snow still lies on the ground, in late May. The nest sites, on low ridges and hummocks, are free of snow, but the flat, marshy tundra around them is still covered. Until the snow melts there is no food for the geese, which graze on marsh plants in the summer, and they have to live on their fat reserves built up before the spring migration.

With timing so critical, any delay in the start of the breeding can be disastrous. If the spring is late and the snow is deeper than usual, or takes longer to thaw from the marshy ground, then either the birds are unable to lay their eggs at all, or if they do, then continued bad weather may force them to abandon their nests. Heavy rain or snow in the period when the eggs are hatching, or the young are still very small, can cause severe mortality.

The effects of weather Bad summers occur quite regularly, but clearly, since the birds do breed in the far north, there are also sufficient good summers. When the geese arrive in the autumn on their wintering grounds in north-west Europe, it is possible to ascertain how well they have bred that summer. The young birds show pale barring on the wings, but lack the white neck marks, and by scanning through the flocks with a telescope the number of young can be assessed. A flock can consist of as many as 50% young birds in a very good breeding year, to none at all in a bad one.



Below: The male and female Brent goose are similar: the upperparts, head, neck and chest are completely black, the only relief being a small white patch on either side of the neck. Underparts vary from dark grey to silvery white.

These enormous variations in breeding success naturally have a considerable effect on the overall size of the population and the way it changes. For example the dark-bellied Brent goose experienced rather more good years than bad through the late 1960s and early 1970s, and this coincided with increased protection as first France, and then Denmark, banned the shooting of them. Britain and the Netherlands, the other two main wintering countries, had protected the Brent in the 1950s. The population rose sharply from about 25,000 in 1964 to 120,000 in 1975, and has gone on rising, though more slowly, to its present level of 150,000.

Finding food While such a massive increase in numbers might seem an excellent thing, causing the bird to be quite common instead of rather scarce and vulnerable, the whole process could be reversed by a sequence of bad years at any time. There has also been an unexpected problem as a result of the increased numbers. Brent geese normally feed on tidal mudflats, grazing on eel grass

(*Zostera*), and on various green algae. The population explosion meant that this food was no longer sufficient for them in some areas so the geese have taken to flying inland to graze on winter wheat fields and on pastures. This has brought them into conflict with farmers who claim that the geese are damaging their crops. Various scaring techniques have been tried, with mixed success, and currently conservation groups are trying to have some feeding reserves set aside for the geese, which will relieve the pressure on the farmers.

Barnacle geese If some of the Brent goose populations have been separated from each other sufficiently long for plumage differences to evolve, the same has yet to happen with the barnacle goose. There are three distinct populations of this species, but the birds in them cannot be told apart.

The three populations breed in East Greenland, in Spitsbergen, and in north-west Arctic Russia. They winter respectively on islands off the west coasts of Scotland and Ireland, on the Solway Firth between England and Scotland, and in the Netherlands. The Russian breeding population is the largest, numbering about 50,000 birds, while the east Greenland stock is rather smaller at about 30,000. Easily the smallest is the Spitsbergen-Solway population, which now numbers about 9000, though it has been much less than this.

Before the war there were a few thousand barnacle geese in the Solway, but disturbance during the war from the several airfields set up in the area to guard the Western Approaches, coupled with shooting for food, was so great that by 1946 only some 500 birds could be found wintering there. There was a very slow increase for the next few years, until in 1954 shooting of barnacle geese was prohibited, and two years later a National Nature Reserve was set up covering the main wintering site at Caerlaverock near Dumfries. There followed a steady increase to 4000 by 1969. Further areas of feeding ground were protected, by the Wildfowl Trust, in 1970, and two years later several of the breeding islands in Spitsbergen were declared sanctuaries. The population responded immediately to this extra protection and rose to 6000 in 1975 and 9000 in 1980.

The barnacle geese arrive on the Solway in late September, and spend the next four months mainly on and around the reserve area. Here they feed on grasses on the saltmarsh and pastures, and glean the barley stubbles. Their distribution is governed to a considerable extent by the amount of wildfowling which goes on around the Solway. There are other areas of good feeding for them away from the reserve, but they can make little use of them until after the end of the shooting season in February. The barnacles themselves are protected but shooting of other geese, pinkfeet and greylags, and of the wide variety of ducks on the Solway, is very heavy and the geese prefer to remain where there is no shooting, on the reserve.

Canada geese In contrast to the highly migratory Brent and barnacle geese, the Canada goose is largely resident in Britain. It is a large bird, with a black head and neck, a white face patch, dark brown upperparts and whitish underparts. This species was originally introduced into Britain from North America in the 17th century. Charles II kept Canada geese with other ornamental waterfowl on his lake in St James' Park in London, and large landowners with lakes in their beautifully landscaped parks followed suit. It was not until the 1950s that birdwatchers or biologists began to take an interest in the Canada goose, by which time the birds were beginning to colonize the many gravel pits being dug along the lowland river valleys of Britain. They also started to move on to reservoirs. A first census of Canada geese in Britain, in 1953, found about 3500 birds. By the time of the next census, in 1968, there were 10,500 and this had risen to 19,500 by 1976.

The great majority of Canada geese in Britain are sedentary, rarely moving more than 20 or 30 miles. However, there is one notable exception to this. Canada geese from North Yorkshire make a summer migration to the Beauly Firth near Inverness, 300 miles away. This is not for breeding, which takes

Brent goose (*Branta bernicla*), about 60cm (23in) from beak to tail. Winter visitor.

Barnacle goose (*Branta leucopsis*), about 65cm (25in) from beak to tail. Winter visitor.

Canada goose (*Branta canadensis*), about 100cm (40in) from beak to tail. Mainly resident.

Below: Barnacle geese are medium-sized, black, grey and white. They have a black head and chest, rather like the Brent goose, but with a creamy white face. The back is black, lightly barred with white, while the underparts are white with pale grey flanks.

place on the many lakes and reservoirs in North Yorkshire, and on some of the high moors. Instead the migration is made by one and two-year-old birds, not yet old enough to breed. They leave Yorkshire in early June and move to the Beauly Firth. Here they spend the period of the annual moult, when like all wildfowl they shed their wing feathers simultaneously and become flightless for a period of about four weeks while their new feathers grow. The Beauly Firth provides them with ample food on the high saltings around its shores, and safety out on the wide expanses of mudflats and water.

Such moult migrations, as these movements by immatures are called, are undertaken by many wild populations of geese, including Canada geese in North America. The main purpose behind them seems to be to take the non-breeders of the population away from the breeding grounds at a time when all the resources of the area are needed by the breeding pairs and their young. They need as much food as possible in order to grow rapidly, before it is their turn to migrate. Most of these movements are to the north, often to areas that are not fully suitable for breeding by geese, but which nevertheless can provide the food and sanctuary required by moulting birds, though for a shorter period than needed for a full breeding cycle. The extraordinary thing about the moult migration of the Canada geese from Yorkshire is that neither of these reasons is applicable. There seems to be plenty of room in North Yorkshire for all the Canada Geese to spend the summer, and there is no reason to think that they could not live all the year round on the Beauly Firth if necessary. The moult migration is thought to have started in the early 1950s, or nearly 300 years after the original Canada geese had been brought over from North America. We shall probably never know what started the migration–initially by 40 or 50 birds and now undertaken by up to 800–but it appears to be some remarkable throwback to the behaviour of their wild forbears in North America.

Above: In spring, barnacle geese feed intensively, putting on weight to last them through the migration and also, in the case of the females, to provide the energy necessary for the formation of eggs. The birds generally leave the Solway Firth in late April and fly direct to north Norway where they pause for two or three weeks, feeding on some of the myriad small islands lying off the coast.

The pecking order–social status in birds

In communities of birds of the same species, such as geese, living together, it is quite common for an order of dominance, a 'pecking order', to become established. You can see this phenomenon frequently in farm yards, where the principal cockerel lords it over the other cocks and hens. Under him there will be a second, subordinate, bird able to defeat all the others (in a dispute over food for instance), and so on all down the line. If a particular hen becomes the favourite mate of the cockerel, she will adopt his dominant status, however lowly her previous position.

Pecking orders also occur in the wild. The Bewick's swan, for instance, wintering at Slimbridge in Gloucestershire, has such an order. Larger families with four or five young are dominant over smaller families with only one or two young. These in turn can successfully drive off a pair without any young, or unpaired birds, from a favourite part of the lake.

TIP LIFE: A THROW-AWAY SOCIETY

To many of us, the rubbish tip is just the end of the road for all our unwanted articles: but on the heaps of refuse life begins anew, and wildlife finds a new habitat.

Although rubbish tips may seem to be unlikely havens for wildlife, they support an astonishingly large and varied number of plants and animals, including some species that are seldom seen elsewhere in Britain. Rubbish tips are among the few places where common species can be seen side by side with the more exotic: wild flowers, cultivated blossoms and even sub-tropical vegetables seem at home.

Urban rubbish tips are relatively recent phenomena, originating in the 19th century when the populations of towns increased dramatically. Rubbish is usually transported to areas of wasteland on the outskirts of towns where it is dumped. In the current method of disposal, known as controlled tipping, the rubbish is deposited in shallow layers, each covered by a layer of soil. Sites chosen for tipping are usually those considered unsuitable for building or agricultural development and include such places as heathland and marshes.

Being set apart in this way, the rubbish tip is an ecological island – it has conditions quite different from those of the adjoining land, and therefore has its own characteristic plant and animal communities.

A new life for gulls Until the middle of the 19th century gulls were regarded as seabirds or else birds of the open countryside. Gradually, however, they became adapted to urban conditions and are now among the

Above: A corporation tip, for gulls a providential supply of food. The tip develops as a habitat. First comers are the scavengers; these, many of them invertebrates and microscopic creatures, convert the waste materials into nutrients for plants. As plants grow, plant-eating animals and insects take up residence, some to end up as food for the predators. The warmth of decay often stimulates the growth of plants and animals.

Right: House crickets sometimes breed in huge numbers in the warmth of the tips.

chief scavengers on refuse, taking over niches previously dominated by such birds as crows. Gulls have found well-established rubbish tips, with their deposits of food and abundance of insects, so attractive that they have forsaken the sea for the security of this man-made habitat. The lesser black-backed gull, for example, once only a summer visitor to Britain, is now partly resident, thanks to this reliable food source.

Predators and prey Gulls are drawn to rubbish tips not only to feed on the waste, but also to prey upon some of the small animals found there. The first visitors to rubbish tips are scavengers that feed on the raw refuse before it becomes covered with soil or overgrown. Apart from gulls, the most common scavengers are crows and starlings, brown rats and house mice, and insects and other invertebrates. The largest predator to be found on rubbish tips is probably the fox, an animal that has readily adapted to urban life and not only hunts living prey but also scavenges among refuse.

Other predators include bats, some of which are said to be particularly attracted by the chirping of crickets. In the London area the noctule bat is the one most frequently encountered, while elsewhere such species as pipistrelle and serotine bats are common visitors.

The largest group among the rubbish tip predators is the birds; besides gulls, crows and starlings these range from kestrels and owls to robins and flycatchers.

Breaking down the waste Scavenging among the refuse are armies of invertebrates: among insects most readily associated with rubbish are flies–bluebottles, houseflies, fleshflies and the tiny owl midges. Springtails are found in great numbers, and there is one springtail species whose only British habitats are the industrial rubbish dumps of South Wales and Lancashire. Other invertebrates include woodlice, earthworms and roundworms.

These small organisms consume the waste food and other organic substances such as paper and leather. Their natural cycle, and the growth of bacteria and some fungi, all work together to convert the organic materials of the rubbish tip into fertilizers that nourish the colonizing plants.

Plant succession Conditions for plant life on refuse tips are extremely unstable. Any plant that colonizes this type of habitat has to be fast growing and able to withstand sudden changes in the environment. In the midst of the process of converting waste into fertilisers, periods may occur when nutrients are washed away and plants show distinct signs of chlorosis (yellowing of the leaves) due to shortage of nutrients, such as nitrates. Groundsel, shepherd's purse, petty spurge and fat hen are among the quickest to become established, and mosses, which grow rapidly, provide a degree of shelter for other plants that consequently flourish.

Perennial plants soon become established and the familiar docks, daisies and dandelions appear at an early stage in the development of a dump. These are followed by such plants as thistles, hawkweeds, rosebay willowherb and stinging nettle, the latter in places where the soil is particularly rich in nitrogen. As well as common wild plants, various cultivated garden species may be found. These are garden 'escapes', which find their way to tips in a number of ways, for example by being transported there in seed form by birds or by the wind, or as part of garden refuse. As a result, many sites are adorned by such attractive flowers as evening primrose, hollyhock and Michaelmas daisy.

Butterfly bush One of the garden plants to have established itself in many urban areas is the buddleia shrub, otherwise known as the butterfly bush. Where it grows on rubbish tips, its flowers are visited by many butterflies, particularly the small tortoiseshell and peacock whose caterpillars may feed on nearby nettles, and the large and small whites from brassica plants which include cauliflower, kale and cabbage. Rosebay willowherb is the foodplant of the spectacular elephant hawkmoth caterpillar, while ragworts support the black and orange banded caterpillars of the day-flying cinnabar moth.

Exotic plants Kitchen refuse contributes its share of interesting plant species, beside the better-known vegetables such as potatoes and cabbages. Refuse tips support imported vegetables and fruits such as melons and mung beans which have found their way from the kitchen rubbish bin. They often flourish for a time until they are killed by cold weather.

The bird seed that arrives at the tip via the refuse from the cages of budgerigars and

Above: Plant-eaters such as this vole come to the tip once the plant life is well established. Other herbivores that may be found there are mice and rabbits, and a vast number of insects. Seedheads attract sparrows, chaffinches and goldfinches.

canaries often produces plants that would not usually be seen in Britain. The most common of these are canary grass and sunflowers. Another item in bird seed is hemp, which also sometimes grows on the tips–in hot climates this plant yields the drug marijuana.

Some of the more unusual plants have seeds that lie dormant and buried for many years but germinate when favourable conditions prevail. The notoriously poisonous thorn apple, a native of America but once widely grown here for medicinal purposes, is a typical example and is found on refuse tips from time to time. Oxford ragwort is very much at home among the ash and rubble of rubbish tips, for its natural home is the ashy volcanic soils of Sicily.

Hothouse conditions The processes of decomposition taking place in the rubbish layers cause a considerable build-up of heat. In fact, rubbish tips behave like giant compost heaps and the increased temperature permits the survival of various species that are otherwise seldom seen in the wild in Britain. The house cricket is a native of North Africa and southern Asia, and is so much at home in the congenial warmth of the rubbish tip that its numbers have grown spectacularly in this habitat. For similar reasons both common and German cockroaches can be seen, and on sites near docks and shipyards other foreign species of cockroach may occur. House mice survive the winter months among the refuse.

Future of the tip It is very likely that these fascinating man-made habitats may not be with us for many more years as more economical methods of waste disposal have been devised due to pressures on land use and to conservation considerations. Modern waste disposal methods include incineration, reclamation of metals by mechanical sorting and composting of organic waste to produce fertiliser. Although these methods may be more acceptable to society today, an interesting question arises as to what will happen to the animals that frequent rubbish tips, particularly species such as gulls that have adapted their feeding and migration habits.

Visitors beware While rubbish tips offer fascinating fields of study, it should be remembered that they are potentially dangerous places, with haphazard deposits of poisonous or inflammable material, broken glass, and piles of rubbish that may collapse at any moment. You should therefore seek permission and advice before visiting a tip.

Left: Sometimes the caterpillars of the cinnabar moth are seen out in strength, feeding on Oxford ragwort.

MIGRANT BUTTERFLIES

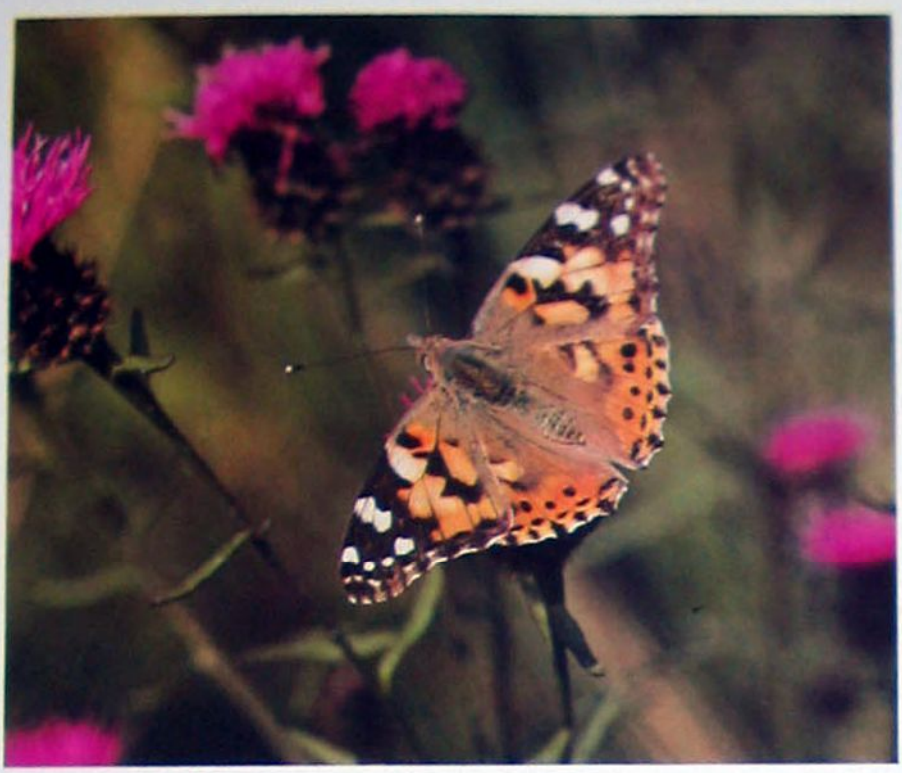
Some butterflies seen regularly in Britain cannot survive our winter, so their appearance here is dependent upon migration from their main breeding areas in the Mediterranean region.

The most regular of the migrant butterflies to reach Britain are the red admiral, painted lady, clouded yellow, pale clouded yellow and Berger's clouded yellow, but a number of other species, including the Continental race of the swallowtail, the Bath white, Queen of Spain fritillary, long-tailed blue and short-tailed blue, reach our shores from time to time. Moreover, some of our resident species, such as the large, small and green-veined whites, peacock and small tortoiseshell, are supplemented by considerable influxes from the European mainland. Finally, a few monarch butterflies occasionally find their way here across the Atlantic from North America, but are unable to breed because of the absence, except as a scarce garden plant, of their foodplants – various species of milkweeds *(Asclepias)*.

A familiar threesome The most commonly seen of the migrants are the red admiral, painted lady and clouded yellow. All three arrive in southern England in the spring and early summer. They lay eggs which give rise to a British-bred summer generation of butterflies; these fly until the onset of prolonged cold weather in the autumn causes them to disappear.

Until comparatively recently it was believed that the vast majority eventually died, only a few red admirals managing to hibernate. Now, however, there is some evidence that many of them fly south in the same way as do those birds which are summer visitors to Britain. The essential difference is that these butterflies which return south are not the same individuals which reached Britain in spring, but their offspring. With our summer migrant birds, of course, the surviving parents as well as their progeny make the return migration. By migrating south, these British-

A red admiral butterfly on ivy. Some red admirals seem to be able to hibernate through a British winter in the adult state. Fully proven records are few, but an analysis published in 1972 by Dr Robin Baker showed that there is sufficient evidence to conclude that hibernating red admirals could be overlooked because the sites they choose – high up in trees, either exposed on the trunks or hidden among dead leaves and ivy – are not well known. Dr Baker has even argued that red admirals are probably mainly resident in the British Isles; but most entomologists still believe it most unlikely that this butterfly could perpetuate itself here indefinitely by this means and without immigration.



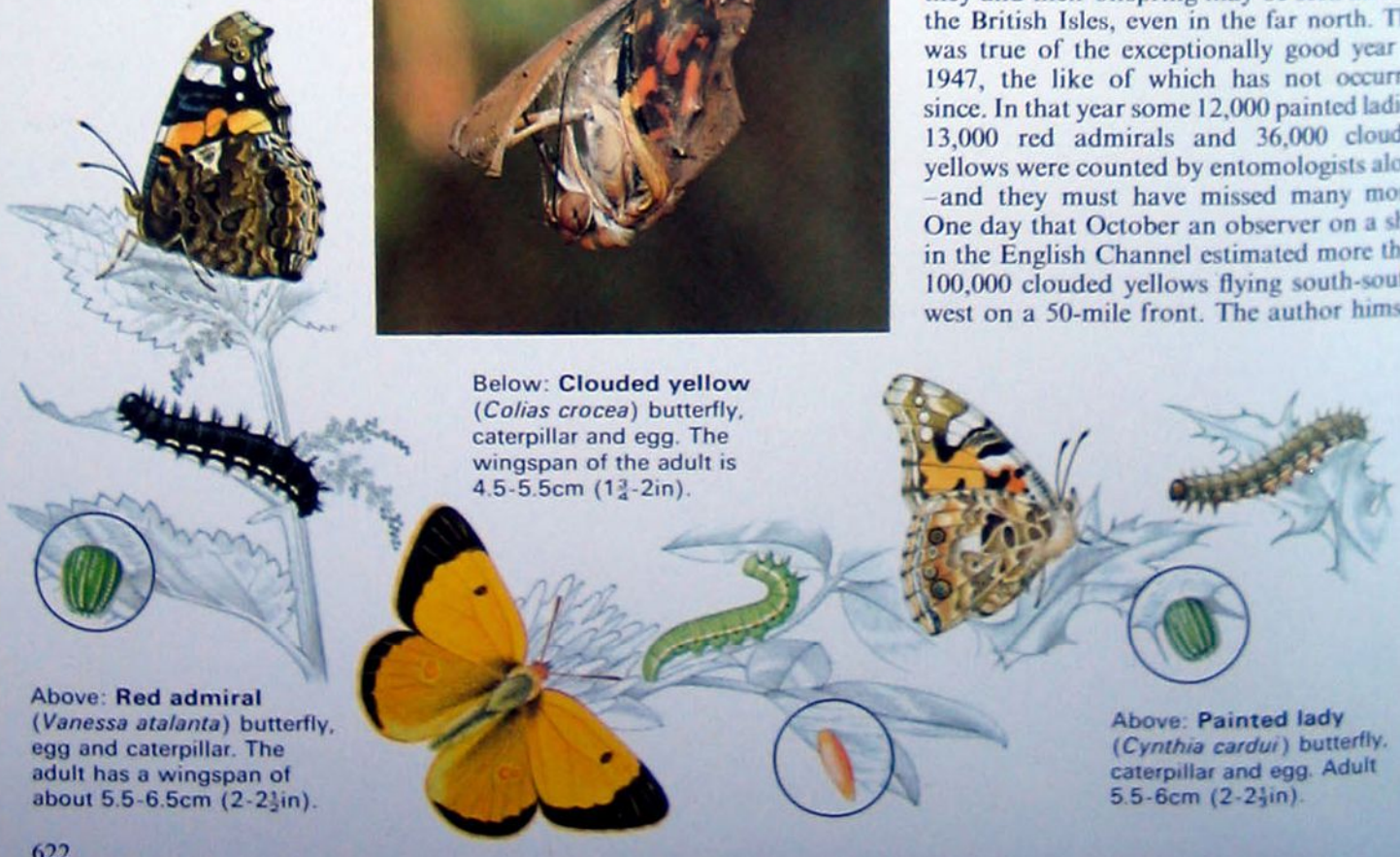
Above: A painted lady butterfly feeding on a thistle. The sexes are similar except that the males are slightly smaller and have more pointed wings than the females.
Right: When the painted lady emerges from its chrysalis, it is suffused with a lovely pink tinge which, unfortunately, it soon loses.

bred butterflies would be able to continue breeding successfully, thus making the migratory habit thoroughly worthwhile for guaranteeing the survival of the species.

It is well worthwhile looking for these return migrations in favourable locations, such as the southern coasts or islands of Britain, or from the shores of inland lakes or broad rivers where the butterflies are not deflected from their migratory path by trees, hills, buildings or the need to refuel with nectar from flowers. But even in less favourable places inland, such movements can be looked for. North-south aligned valleys in hill and mountain ranges are other possible places where migrations, not unlike those seen on a huge scale through the high passes of the Alps and Pyrenees, may be seen.

The existence of a partial return autumn flight in migrant butterflies and other insects proves that the regular movements of these species are true migrations of biological value to the individuals that perform them, and not simply overflows due to overcrowding and food shortage in their normal breeding area. Otherwise the offspring that hatch in Britain would fail to breed and therefore be wasted. It also explains the persistence of the migratory habit in the absence of such overcrowding.

Fluctuating numbers The number of red admirals, painted ladies and clouded yellows arriving here each spring varies a great deal, especially those of the last two; in some years they may be abundant, in others quite rare. In a bad year those that do arrive may not penetrate much beyond the southernmost counties of England; but, in a good year, they and their offspring may be seen all over the British Isles, even in the far north. This was true of the exceptionally good year of 1947, the like of which has not occurred since. In that year some 12,000 painted ladies, 13,000 red admirals and 36,000 clouded yellows were counted by entomologists alone –and they must have missed many more! One day that October an observer on a ship in the English Channel estimated more than 100,000 clouded yellows flying south-south-west on a 50-mile front. The author himself



Above: **Red admiral** (*Vanessa atalanta*) butterfly, egg and caterpillar. The adult has a wingspan of about 5.5-6.5cm (2-2½in).

Below: **Clouded yellow** (*Colias crocea*) butterfly, caterpillar and egg. The wingspan of the adult is 4.5-5.5cm (1¾-2in).

Above: **Painted lady** (*Cynthia cardui*) butterfly, caterpillar and egg. Adult 5.5-6cm (2-2½in).

Above: The main breeding area of migrant butterflies is in the Mediterranean region. The adults fly up through Europe across a broad front, and arrive in Britain by May or June.

Below: A clouded yellow butterfly. A white or pale yellow form of the female, known as *helice*, is quite common and can be mistaken for the pale clouded yellow or Berger's clouded yellow – both rarities – which are far less heavily marked with black on the hindwings.

remembers seeing fields in Kent almost yellow with butterflies that passed in a constant procession under his classroom windows throughout the summer.

In these good years, exceptional population explosions seem to occur in the butterflies' chief breeding grounds around the Mediterranean, where all three species produce a series of broods throughout the year. As a result, many more migrate than usual to find suitable breeding places elsewhere. The search for nectar by these highly active butterflies may be one of the chief stimuli for them to migrate: hot, dry weather in particular may so parch the flowers on their home ground that nectar is in short supply, especially when their numbers are high, and so they are obliged to seek it further afield. They are more likely to find abundant flowers to the north than to the south where deserts prevail.

Sometimes conditions in the Mediterranean region cause these butterflies to appear in northern Europe, including Britain, at unseasonal times of the year. This most often happens with the painted lady which, incidentally, is one of the most widely distributed butterflies in the world. For example, in 1952 painted ladies arrived as early as the beginning of February and on through March in considerable quantity. Similarly, some painted ladies appeared in England early in March 1977, along with some moths from the western end of the Mediterranean. On this occasion, their arrival was correlated with a very warm southerly airstream over north-west Africa and western Iberia which reached southern England on March 2nd.

Some individuals of all three species migrate every year. How they normally find their way is not yet fully understood, but there is some evidence that they can orientate by the position of the sun and make adjustments for the wind's direction and speed. But like birds, they can be temporarily swept off their normal path by abnormal weather situations and their associated wind systems. This can lead to some butterflies turning up in unexpected places, and can account for the appearance of a rare species.

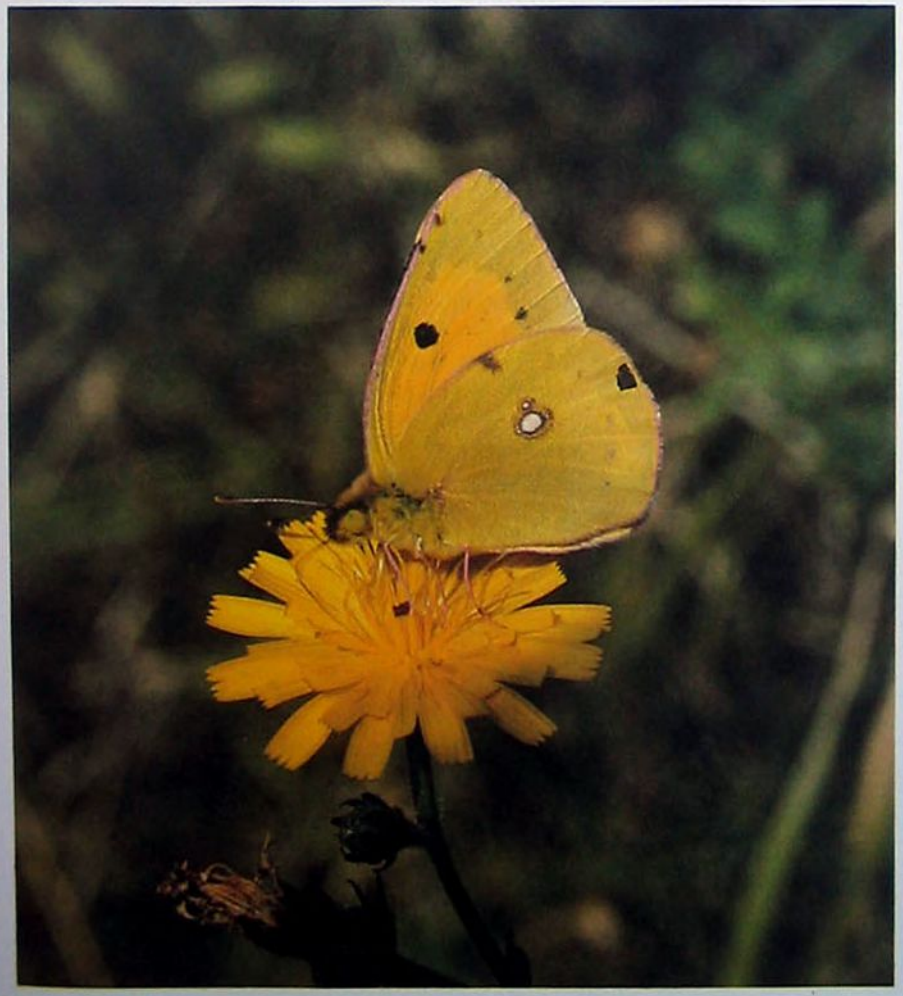
Life cycles However they get here, the migrant butterflies fly actively in search of nectar and the right foodplants on which to lay their eggs. They are not restricted to any particular habitats, so can be found feeding at flowers almost anywhere from a city park or garden to open moorland. If you want to observe these butterflies on your garden, the best plant to attract them is the sweet-scented buddleia – justly known as the 'butterfly bush'.

However, the places where they can breed are more limited: female painted ladies deposit their eggs on thistles and sometimes on stinging nettles, burdock and a few other plants; red admirals on stinging nettles; and clouded yellows on various leguminous plants, especially clovers and lucerne.

On emerging from their green eggs, which are laid singly, each spiny, greyish-coloured painted lady caterpillar draws together a leaf with silk and feeds concealed within its shelter. When full-grown, the caterpillars form 'tents' by spinning the surrounding leaves together and, suspended upside down from a silk pad, change into greyish chrysalids spangled with silver or gold. They emerge about two weeks later.

Red admiral females also lay green eggs singly on the leaves of the foodplant and their caterpillars feed and pupate in silk shelters spun among the leaves, like those of the painted lady. Similarly, their reddish-brown chrysalids are spangled or studded with metallic gold spots and the butterflies emerge from them in about a fortnight. Although the females tend to be slightly larger, the sexes look alike.

When first laid, the eggs of the clouded yellow butterfly are pale yellow, but they soon turn to orange. They are also laid singly or in small batches on the upper leaf surface of the foodplant. The well-camouflaged, velvety-looking green caterpillars feed quite openly on the foodplant on which they also pupate. The yellowish-green chrysalis is attached to a stem by a silk girdle and resembles a withered leaf. Late caterpillars and chrysalids perish during the winter; otherwise the butterflies usually emerge from the earlier chrysalids in August.



MAMMAL TEETH: HERBIVORES

Seed-nibbling mice, nut-cracking squirrels and grass-grazing horses are just a few of the wide range of mammals that have teeth adapted for feeding on plant material.

Eating plants wears out teeth faster than crunching or gnawing at even the hardest bones. Plants are less nutritious than meat, so herbivores spend longer feeding, and their teeth wear more quickly. Additionally, grass, the main diet of most specialist plant-eaters, contains abrasive silica salts in its stems and leaves which act like sandpaper when the teeth bite and grind.

While a meat-eating mammal normally retains the enamel covering of its teeth in good condition the whole of its life, a herbivore grinds down the enamel, and then the dentine is exposed. The bone-like dentine and enamel wear down gradually, the former at a quicker rate so that the enamel appears as ridges. Herbivores have different sets of teeth for biting and chewing, which are separated by a gap, known as the diastema. The incisors nip off the plant, and the cheek teeth grind and chew each mouthful before it is swallowed.

Horses and ponies have a maximum of 40 teeth, many more than the other species of herbivore. The row of six incisors in the top jaw are used to crop grass by biting against a similar row in the bottom jaw. The incisors of a young horse are completely covered in enamel, but constant grazing soon wears the tips down and reveals the dentine. The incisors do not grow any longer to compensate for this wear, but the rate of wear is slow.

When a mouthful of grass has been cropped by the incisors, it is moved back in the mouth and chewed by the long straight row of specialised cheek teeth. Horses' cheek teeth, like those of all herbivores, look very different from the cheek teeth of carnivores. The teeth are long and the crown is flattish with ridges of enamel rising above dentine and cement. Instead of just fixing the root in its socket, the cement fills the grooves and crevices in the sides of the teeth.

The enamel ridges of the top and bottom rows of cheek teeth grind against each other in a sideways action and chew the grass very effectively; this is important since plant food can only be properly digested when the plant cell walls are broken, so that the cell contents are exposed to the animal's digestive juices.

Male horses usually have small canines in the gap between incisors and cheek teeth. They seem to be of no help with feeding, but may be used when stallions bite each other during their fights for females.

Deer digestion is helped by their food being chewed twice. Deer use their incisors to crop grass but, unlike horses, they have incisors only in the lower jaw. They bite against a leathery pad in the upper jaw, and this may help to reduce wear on the incisors.

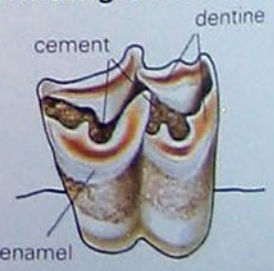
The lower jaw of a deer appears to have four incisors on each side, but the fourth incisor is in fact a canine which has become adapted for grass cutting rather than fighting. In the upper jaw, not only are there no incisors, but fallow and roe deer have no canines either. Red and sika deer have small upper canines rather like those found in male horses. Deer stags use antlers rather than teeth for fighting each other, and it is interesting that the only deer in Britain to have large, tusk-like canines are the Chinese water deer which do not have antlers.

Deer have 12 cheek teeth, and the enamel ridges run in new-moon-shaped crescents along their length. The top and bottom teeth together form a 'grinding mill' for effective chewing.

Chewing the cud While meat-eating mammals have lower jaws which only bite up and down, all the herbivores can move their lower jaws from side to side–a movement which is easiest to see when a cow or a deer is 'chewing

Above: A grey squirrel gnawing an acorn. As in all rodents, the actual gnawing is done primarily by the incisors of the lower jaw, while those of the upper jaw have the task of fixing the head in position while the lower teeth gnaw. To eat a harder nut such as a hazelnut, the squirrel holds the nut firmly with its forefeet and gnaws a groove across the top until a small hole is produced. Then it inserts the lower incisors into the hole to crack the shell.

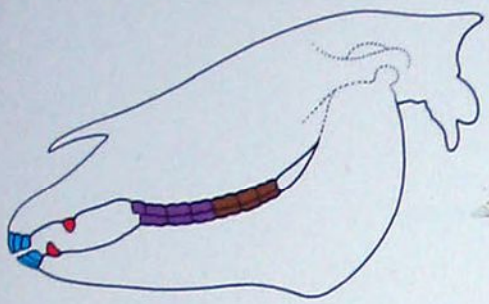
Grinding cheek tooth

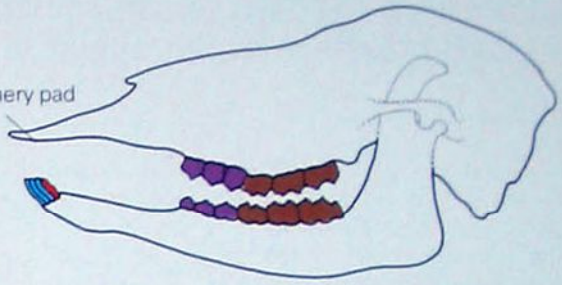


A long-crowned cheek tooth of a roe deer, showing typical structure of a herbivorous mammal. The enamel ridges act as rasps for grinding green vegetation.

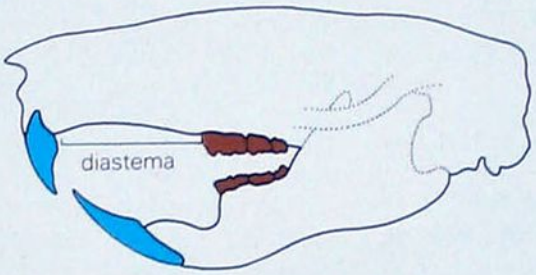
The teeth of grazers and gnawers

Left: 'Long in the tooth' in a horse refers to the teeth becoming more exposed and thus appearing longer as the horse ages. Canines are present only in stallions and may be for use in fights for females. Dental formula: I $\frac{3}{3}$ C $\frac{1}{1}$ PM $\frac{4}{3}$ M $\frac{3}{3}$.





Right: The rat has a typical rodent tooth dentition. The ever-growing front incisors are kept at usable lengths as they wear down at the same rate as they grow—as much as 15cm a year. Dental formula: I $\frac{1}{1}$ C $\frac{0}{0}$ PM $\frac{0}{0}$ M $\frac{3}{3}$.



Above: Spatulate lower incisors and canines of the fallow deer crop foliage by cutting against a leathery pad in the upper jaw. This may help to reduce the wear on these teeth by coarse grasses. Dental formula: I $\frac{0}{3}$ C $\frac{0}{1}$ PM $\frac{3}{3}$ M $\frac{3}{3}$.

incisor premolar

canine molar

the cud'. When feeding, a deer is usually out in the open and exposed to danger, so it eats swiftly, giving each mouthful a quick chew before swallowing. When the deer is resting, safely hidden, it regurgitates each mouthful of food, known as the cud, and gives it a thorough second chew before it is swallowed again.

The smaller herbivores, the rodents, rabbits and hares, have cheek teeth that look and work very like those of the larger herbivores, but they do not chew the cud. All the cheek teeth look alike and in the specialist grass-eaters, have enamel ridges across the grinding surfaces.

Many rodents, such as rats and mice, eat flesh as well as plants. Their cheek teeth do not have grinding ridges but low cusps.

No rodent, rabbit or hare has any canine teeth and the incisors are extremely specialised. True rodents, such as mice, rats, voles, squirrels and dormice, have only two upper and two lower incisors. These are curved and have enamel only on the front edge. The exposed dentine on the other side of the tooth wears away quicker and keeps the incisors always chisel sharp.

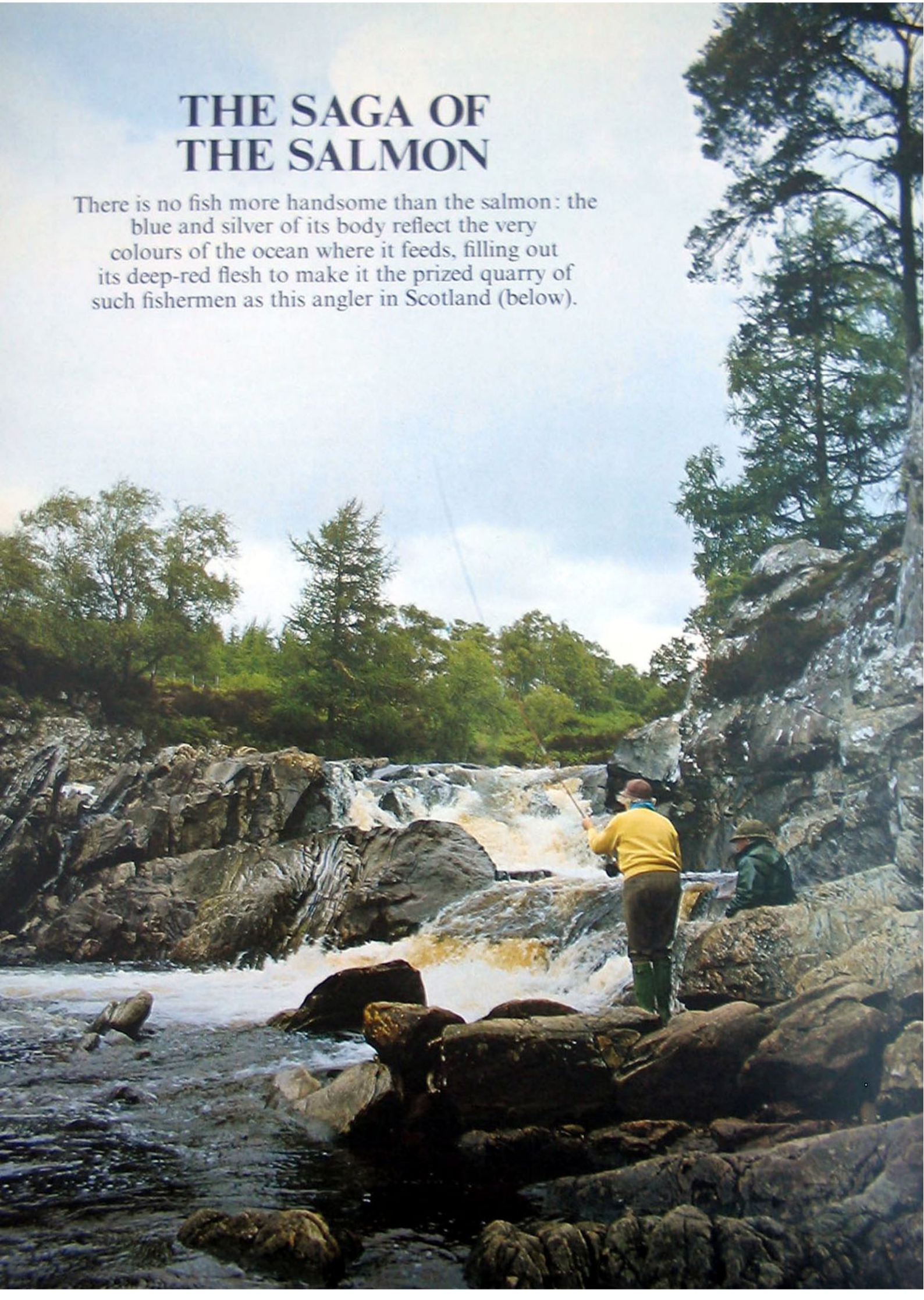
Rodents' incisors grow very quickly—a rat's incisor grows between 10 and 15cm (4 and 6in) a year—but wear away at the same rate. They have fewer teeth than most other mammals. Mice and voles have 16, the lowest number in British land mammals.

Right: The cutting incisors of a rabbit are chisel-sharp. Ridged cheek teeth grind the cropped plant's cell walls to a digestible pulp. Rabbits need to eat 500gm of vegetation daily to be in good health.

Below: Sheep grazing peacefully above the River Tweed, Peebleshire, Scotland. Being ruminants, they give the grazed grass a quick chew before swallowing and later regurgitate the 'cud' to grind it thoroughly.

THE SAGA OF THE SALMON

There is no fish more handsome than the salmon: the blue and silver of its body reflect the very colours of the ocean where it feeds, filling out its deep-red flesh to make it the prized quarry of such fishermen as this angler in Scotland (below).



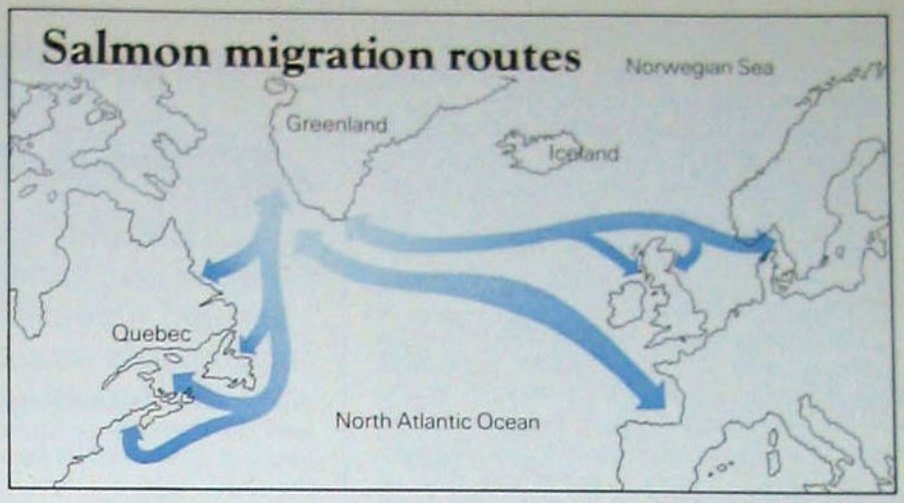
The Atlantic salmon (*Salmo salar*) is a migratory fish found in the temperate and Arctic regions of the northern hemisphere. There are few fish that have such a fascinating life cycle. The salmon uses the gravel in the streams and rivers for the protection of its eggs and the fresh waters themselves for the nursery stages of its young. Then, when the young are 10-15cm (4-6in) long, and able to cope with conditions at sea, they leave the rivers in their thousands to feed voraciously in a rich marine environment, growing to a weight of several pounds in the same period of time that it took them to reach only a few ounces in the river.

The mystery of migration The ocean currents undoubtedly play a part in this fascinating journey as, quite probably, do the stars, the moon and the sun, for salmon travel in the surface waters and so may be able to navigate by them. Once the fish approach the coast on their return journey, and are close to the rivers where they hatched out, new influences take over. One theory is that the characteristic odour or 'taste' of the salmon's parent river is recognised by the returning fish. Recent research suggests that the salmon detects the secretions or 'pheromones' exuded by the young fish of its own breeding stock in the river.

Life in the river Salmon return to their river of origin throughout the year, even though they do not spawn until late autumn or early winter. Some spend two or three years feeding in the sea before returning to the river, while others spend only a little over a year at sea before coming back to spawn. These early-returning fish tend to be smaller and are given the name 'grilse'.

After the salmon has been in fresh water for a few weeks, it loses its silver coloration. The male gradually assumes a red and mottled appearance and develops a thick spongy skin, an enlarged head and a well-developed hooked lower jaw known as a 'kype'. The changes in the female are not so dramatic. She becomes dark brown or purple and grey underneath. By the time she reaches the spawning grounds, she is unable to negotiate obstacles in the river, as the large orange eggs make her body too heavy.

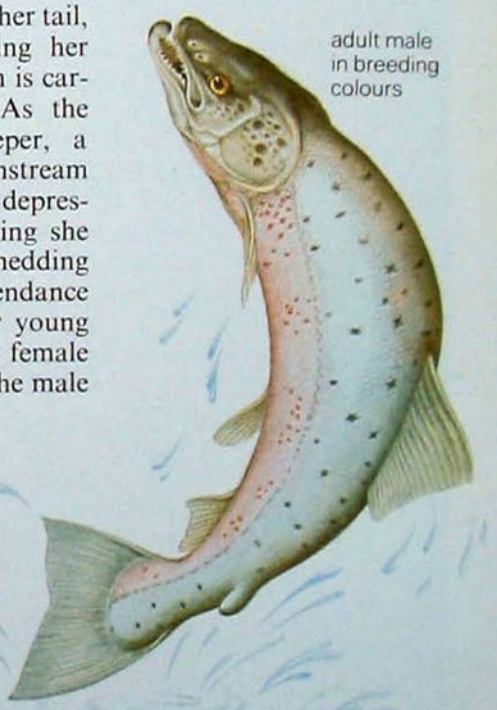
The long fast It is believed that salmon do not feed in fresh water, but this makes it difficult to explain why they are caught by anglers using artificial flies, minnows and fresh garden worms as bait. The actual point in their return migration at which food intake is reduced is not known but salmon taken in nets along the coast frequently have stomachs full of sandeels. On entering the river the salmon's stomach shrinks and the only food it can swallow consists of soft-bodied organisms such as worms, which can be digested with the minimum expenditure of energy. Very occasionally, young salmon have been found in the stomachs of male salmon on the spawning grounds, probably taken while chasing away intruders. The fast can be very long and the fish do not start feeding again until their return to the sea early in the following year.



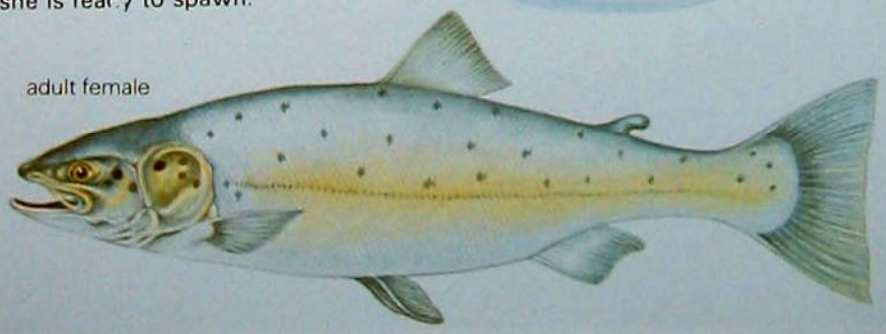
Above: The Greenland feeding migration of the salmon. It is only within the last twenty five years that the salmon's sea feeding grounds have been located off Greenland and the Faroes. Details of the navigational aids used as they migrate to, and find their way back from, the rivers in which they were hatched, are still something of a mystery.

Spawning time As autumn approaches, the smaller streams with their clean beds of silt-free gravel and cool, well-oxygenated water are gradually occupied by the ripening adults. By early November spawning starts and, with the appearance of late-comers, may continue well into December.

When the female is ready to spawn, she tests the gravel, cutting a well-defined, saucer-shaped depression to see if it is suitable for her nest. She does this by turning on her side and producing a vigorous flapping of her tail, alternately bending and straightening her body and dislodging the gravel which is carried downstream by the current. As the saucer-shaped depression gets deeper, a mound of gravel appears on the downstream edge. When the nest, or 'redd' as the depression is called, is to the female's liking she 'crouches' in the gravel prior to shedding the eggs. The male fish, always in attendance unless chasing away other males or young salmon, darts forward. Then, as the female bends her body and ejects the eggs, the male



Right: A male salmon in breeding colours. One characteristic for which the salmon is famed is that of jumping. Salmon have been recorded jumping successfully over vertical falls as high as 4m (13ft). The female fish (below) becomes brown or purple, with grey underparts, when she is ready to spawn.



starts to shed his milt. The female covers the fertilised eggs with gravel as she moves upstream and excavates another redd.

All fish that have just finished spawning are referred to as kelts until such time as they reach the sea. Some kelts return to the sea shortly after spawning, while others do not leave the river until March, April or even May, and only 3-5% return to spawn a second time in later years.

The young stages Throughout the long winter months the large, orange, yolk-filled eggs lie under 15cm (6in) or more of gravel and are washed over by cool, well-oxygenated water. The eggs develop 'eyes' by late January as the salmon embryos grow, the rate of development depending on water temperature. By the end of March the young salmon or alevins break out of the egg and at first bear little resemblance to a fish, owing to the large yolk sac suspended from their 'stomach'. After a few weeks, their yolk sacs disappear and they become miniature fish, ready to feed.

The term 'fry' is given to salmon during their first year of life, at the end of which time they are called 'parr'. An interesting aspect in the life of the parr is that some of the males became sexually mature in the autumn. The testes of these fish develop fully and the milt from them is capable of fertilising the eggs shed by the adult female.

River departure The transformation from the parr to the 'smolt' stage starts in the spring when those parr which have reached a length of 10cm (4in) or more develop a silvery coating on their scales and their tail fins become black, so that they look very much like miniature salmon. Many factors trigger off the downstream movement of smolts, including a rise in water temperature, and an increased river flow as a result of rain. It seems likely that smolts need some time to become acclimatised to the salt water, as they often remain in the estuary for a short time before entering the sea.

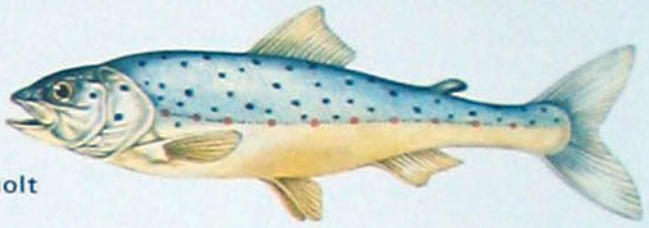
Enemies and diseases Like most fish, the salmon has a number of enemies. During its river life the main predators are pike, cormorant, goosander, red-breasted merganser, heron, mink and otter. All these eat parr and smolts; the pike and the goosander having the most serious effect on the stock of young salmon. Only the otter regularly kills adult salmon, although cormorants have on occasion been recorded taking small salmon, chiefly grilse. The most serious predator of salmon at sea is the grey seal, which eats as much as 7kg (15lb) of fish a day. Attempts have been made to reduce the numbers of grey seals by annual culls of pups but there is strong opposition to these continuing or being stepped up until more information is available on the feeding habits of the seal.

The two most serious diseases affecting salmon are furunculosis and ulcerative dermal necrosis, or UDN for short. The former is a bacterial disease which affects salmon during the low water conditions of summer droughts when the water temperature is high and the fish are concentrated in the rivers in large shoals. It is not known for certain what causes UDN, and although scientists have studied the disease the organism responsible has not been found. Some believe it to be a virus, while others suggest that it may be caused by sensitivity to solar radiation as a result of some food they have consumed. Whatever the cause, the symptoms it produces are most unpleasant. Salmon are more susceptible to such diseases as they are weakened by the efforts of their migratory journeys, and many fish die each year.

Stages of salmon growth

Fry is the name given to salmon after the alevin stage, up to one year old. Only 3-5% of fry reach the smolt stage, and only 6-10% of the smolts return to the river as adult salmon.

Parr are 1-3 year old salmon, easily recognised by the distinctive 'thumb' marks on their side, each separated by a red spot. The parr become silver in colour as they grow.



The smolt is the final stage in the development of the young salmon. The parr marks disappear, the markings of the silvery smolt now resembling those of the adult salmon. Smolts move downstream and feed in the estuary for a while, before entering the sea where they grow rapidly. Male fish have reached a length of 1.5m (59in), with a weight of 36kg (79lb), during their lifespan of 4-6 years.

Below: Four day old alevins, their yolk sacs clearly visible. The eggs hatch after anything from 70-200 days, and the egg's yolk then nourishes the alevin for about six weeks, during which time it stays in the gravel and moves around very little. After this time the young salmon, now known as fry, start to feed on plankton.

BLACKTHORN AND CHERRY-PLUM

Blackthorn and cherry-plum may look alike at a quick first glance. But look closer, and you'll see that blackthorn is a prickly, rigid bush with tangled branches, whereas cherry-plum is an elegant tree with smooth bark and larger leaves and flowers.

The blackthorn is a deciduous shrub which is one of the best protected against grazing animals: it positively bristles with stiff, spiny thorns on the twigs, branches and even the stem. It is common throughout the British Isles on most types of soil and in a wide variety of habitats. It is most conspicuous on scrublands where it forms dense, impenetrable thickets, but rarely grows taller than 4m (13ft), and on windswept coastal cliffs it is shaped and stunted by the prevailing winds.

Blackthorn also grows in woodland but because it needs plenty of light you are unlikely to see it in the shady interior, although it thrives on the edges of woods and in clearings, along road verges, grassy tracks, hedgerows, embankments, and on commons.

The blackthorn is a rigid bush, sending out many branches which further divide to form a close network of twigs, each ending in a sharp point. The bark is usually quite smooth and blackish – hence the name – but the younger shoots are covered with fine downy hairs. The older branches are frequently thickly encrusted with lichens.

Prickly trap It is not surprising that many birds choose to nest in blackthorn bushes, their eggs and nestlings relatively secure from predators by being tucked away in their spiny fortress. The most important is the red-backed shrike, a rather rare bird which has an interesting habit of impaling its prey on to the tips of thorns. The shrike's 'larder' is a store of surplus food which is either eaten later or fed to the young.

The blackthorn's tight prickly growth would seem to make it an ideal hedging plant

Below: Blackthorn breaks into a mass of blossom in spring. As with hawthorn, it is considered unlucky to bring the blossom into the house or wear it in a buttonhole.

Above: Sloes are hard to collect because blackthorn bushes are so prickly, but added to gin, they make a delicious drink.

Right: **Blackthorn** (*Prunus spinosa*). Deciduous, native, grows to 4m (13ft) in scrub, woods, hedges. Flowers April, sloes Aug-Sept.

Below: The remains of a lizard impaled on blackthorn. Beetles, frogs, bees and nestlings are also stored in this way and eaten by the red-backed shrike.

for creating stockproof barriers. Indeed it is, but there is one drawback: blackthorn sends up erect shoots or suckers from its roots, often several feet from the main stem. If these are not cut back they gradually spread out into the pasture, eventually forming a dense thicket that is difficult to remove. This suckering habit means that a large clump of blackthorns can result from just one plant spreading vegetatively.

Flowers The blackthorn flowers early, in March or April, before the foliage appears. Each flower is composed of five pure white petals, and they are pollinated by insects. In some years the starry blossoms cover the twigs in such profusion that you can hardly see the bark.

Many people believe that if the weather is cold when blackthorn blossom appears then it will remain cold for the whole flowering period – about a fortnight – a so-called blackthorn winter. It is easy to dismiss these age-old beliefs, but there was a typical blackthorn winter in 1981: a week of below-average temperatures in mid-April culminated in blizzards which swept across most of the country, cutting off farms and villages and causing chaos on the roads. The fact is that the flowering of blackthorn does often coincide with a cold winter.

Leaves The leaf buds are spaced alternately along the twigs and the foliage unfurls in May. The leaves are small, about 3cm (1in) long, oval in shape with finely toothed margins. A large number of moth caterpillars feed on the leaves, as do the caterpillars of two small butterflies, the brown hairstreak, and the rare black hairstreak, which is known only in a few places in the Midlands. After mating the females of both species lay their eggs on blackthorn twigs where they pass the winter before hatching early the following summer.

Sloes The flowers are succeeded by hard green fruits which ripen and swell during summer to become the familiar small, round, blackish plums called sloes. Each one is about 15mm ($\frac{1}{2}$in) across and the black skin is usually coated with a dusty bloom which gives them a bluish-grey colour. A single round stone is embedded within the greenish-yellow flesh.

Sloes are extremely sour and if you bite into one it will set your teeth on edge. However those fruits that linger on the bush for a month or so do become slightly sweeter. Sloes can be used with sugar for making wine or steeped in gin to produce sloe-gin, an excellent liqueur-type drink.

Blackthorn wood is hard and the grain forms intricate patterns of colour. The straight stems from younger bushes make handsome walking sticks. In Ireland the shillelagh, a fearsome cudgel traditionally carried for personal protection, is usually fashioned from blackthorn. Shillelaghs are still made today for sale as tourist souvenirs.

The cherry-plum or myrobalan is a small deciduous tree growing to about 8m (26ft) in height. The trunk, which is covered with smooth blackish bark, sends out slender branches to form a rather narrow, rounded crown. As a young bush it can easily be confused with blackthorn but the twigs are much less thorny and the leaves are generally larger – up to 7cms (3in) long.

The cherry-plum is native to Asia Minor and it is not known for certain when it was introduced to the British Isles, but it was recorded growing here in the 16th century. It has a rather local distribution, more or less limited to south and eastern regions of England. In some districts it was widely used as a hedge plant, for it tolerates heavy cutting and does not sucker freely like the blackthorn, so is easier to control and maintain. It is also locally planted in shelterbelts around orchards but elsewhere it grows wild in overgrown hedgerows and waysides.

The white flowers are a larger version of blackthorn blossom, about 2cm ($\frac{3}{4}$in) across, but not produced in such quantity. The flowers appear in April, before the leaves unfold, but they are easily damaged by frost and so rarely produce much fruit in the British Isles. In September, if the spring has been mild, the tree becomes laden with reddish 'cherry-plums' each about 2.5cms (1in) in diameter and hanging from a 2cm ($\frac{3}{4}$in) long stalk. They are delicious to eat.

Above and below: Cherry-plum is usually planted along hedgerows although it is occasionally naturalised. It is widely believed that an ancient hybrid between blackthorn and cherry-plum gave rise to all our domestic plum trees including bullaces, damsons and greengages.

Left: **Cherry-plum** (*Prunus cerasifera*). Deciduous, introduced, grows to 8m (26ft) in hedgerows. Flowers March, only fruits in good years.

THE JAY: COLOURFUL CROW

Jays are our most handsome and distinctive crows. They are shy birds, and you never find them far away from trees. In autumn they are busy collecting acorns for their larder–in one wood 30 jays stored an estimated 200,000 acorns in just four weeks!

The jay belongs to the crow family, but it has much brighter plumage than its relatives. At close range it looks quite exotic. Its crest, delicately spotted with white and black on the forehead, is raised when it is displaying to other birds. It has pale blue eyes and a broad black moustachial streak; most of the body is pale pinkish-brown. The flight feathers are black and grey, with a conspicuous patch of white, and the wing coverts are beautifully barred with pale blue and black.

Elusive bird Jays are shy and restless birds, and you may find it hard to get a good view. Most often you just see them flying away, when the large, white patch just above the black tail is very noticeable. They have broad, rounded wings and their flight often looks weak and laboured. At a distance, jays can be mistaken for hoopoes, an unrelated bird found in Europe which is fairly similar in size and shape and also has black, white and pink plumage.

Oak woodland is the jay's preferred habitat and you rarely find them far from trees. Unlike our other crows–magpies, carrion crows, rooks and jackdaws–jays seldom venture out into open fields. When they are searching for food in the trees or on the ground, they tend to hop and leap about, rather than walk or run.

Jays are often quite noisy, so you may hear them before you see them. The main call can be heard from far off. It is a loud, often twice-repeated, rasping shriek of alarm which they make when disturbed. People have also heard jays make a variety of chuckling and chirruping calls, a buzzard-like mew and even a low, warbling song.

Like their relatives, jays are intelligent, opportunist birds, and adapt to various diets. Usually they feed on the woodland floor, eating tree nuts such as beechnuts, sweet chestnuts, hazel nuts, pine seeds and especially acorns. They also eat fruits such as pears, plums, cherries and other soft fruits. In the summer they search for eggs and nestlings of other woodland birds, and they have been seen eating mice, slugs, worms, insects, woodlice, spiders, bread, fish and even bees. In gardens some jays have learnt to eat peanuts by tipping the holder upside down and shaking the nuts to the ground. Unlike crows and rooks, they rarely eat carrion or grain, and they have little effect on agriculture.

Acorn hoarders The jay's favourite food is acorns. In September and October when the acorns ripen you can see jays searching methodically for them in and beneath oak trees. However, instead of eating only what they require and leaving the rest to fall to the ground where all kinds of animals and birds would find them, jays hoard them. By making their own private larder, they can be sure of enough food to last throughout the year.

Jays can hold up to nine acorns at once in their specially large oesophagus, but more usually they take just three or four. They

Above and below: The favourite food of jays is acorns. Each jay's larder consists of several thousand acorns collected over about two months. A storing trip takes only a few minutes, and in autumn you may see jays flying back and forth all day.

Above: An adult jay about to drink water. Jays thrive in most types of woodland, particularly oakwoods, but you occasionally see them in suburban areas and city parks where there are plenty of trees. Note the distinctive blue and black barring on the wing. You can sometimes find one or two of these blue feathers dropped by a jay as it flies over woodland.

take each acorn to a separate place, usually within half a mile but sometimes up to 2 miles away from where they found it. Favourite hiding places are under leaves or roots, in small holes or amongst moss. Sometimes the jay actually makes a hole in the ground with its beak so the acorn is properly concealed.

Jays appear to have excellent memories, because they know every detail of their local wood and they remember where most acorns are hidden. Even when snow covers the ground, they know exactly where to dig. In the summer many uneaten acorns begin to germinate, but jays can also recognise the fresh oak seedlings and dig them up to find acorn remains below.

The acorns are often 'planted' in suitable sites for growing and, when there is a surplus, those that are not retrieved grow into trees and provide food for future generations of jays. So the jay's storing habit ensures the survival of both the jay and the oak. It is probably also the most important method by which oaks spread uphill.

When eating an acorn, a jay usually holds it still against a branch or on the ground with its inner toes. Then with its strong, slightly hooked beak, it levers and tears off the shell to reach the nutritious core.

Jay 'marriages' In spring you may find gatherings of jays known as jay 'marriages'. These are probably courting birds trying to find mates. On some occasions up to 30 jays are present displaying and calling in great excitement.

Jays prefer to nest fairly low down in thick undergrowth – in bushes and small trees, and in evergreens such as ivy, or suckers next to a tree trunk. Occasionally they choose the outer branches of a large tree. Both male and female help to build the well-concealed, robust nest. They use numerous small sticks and twigs and a little earth, and then line the nest with a thick layer of fine roots.

The female usually lays four to six eggs at the end of April or in May, and does most of the incubation. She is very difficult to spot because she crouches very low in the nest, only leaving when her mate comes to feed her and can stay on guard.

The eggs hatch after 16 days but the female still has to brood her family for the first week or so, because the tiny, featherless chicks soon chill if left uncovered for long. At this time the male finds all the food they need. To start with, the chicks look all beak and belly – because they are eating as much

Anting: feather-care

Most birds replace their feathers once or twice a year, but without daily servicing the feathers quickly lose their warmth and waterproofing, and flight becomes inefficient. So birds regularly bathe, preen, dust and oil their feathers even – or especially – in winter when days are short and the water cold. Passerines (perching birds) have developed an additional feather-care technique – anting. In this country it is the jays, rooks, thrushes and starlings that most often do this. The anting bird crouches in a mass of ants, holding its wings out to the ground so the ants crawl over its plumage. Often it picks ants up in its beak and puts or rubs them on the feathers.

There are over 40 species of ants in Britain and most produce toxic chemicals to defend their colony, attack others or immobilise prey. Such poisons are effective against other insects and, while various explanations of anting have been suggested, it is now thought that the birds' behaviour encourages ants to release their 'insecticidal shampoo' on to their feathers, so reducing populations of parasitic insects living within the plumage. Subsequent bathing and preening removes the dead insects. Interestingly, birds never use ants that sting, even though these are common.

food as possible and growing quickly. By the time they are two weeks old, they are big and fat, and all the feathers are sprouting except perhaps the tail which is last to appear. When they leave the nest the young jays already have their adult plumage.

The jay parents collect a special diet for their nestlings. Mostly they choose leaf-eating caterpillars from nearby trees and bushes, storing them in their throats until they have enough to give each nestling a good mouthful. The chicks wait silently for a parent to land beside the nest, and then reach up and open their beaks wide. The parent carefully puts food down the bright orange-pink gape of each chick in turn. If one gets too much to swallow, some is taken away and given to another.

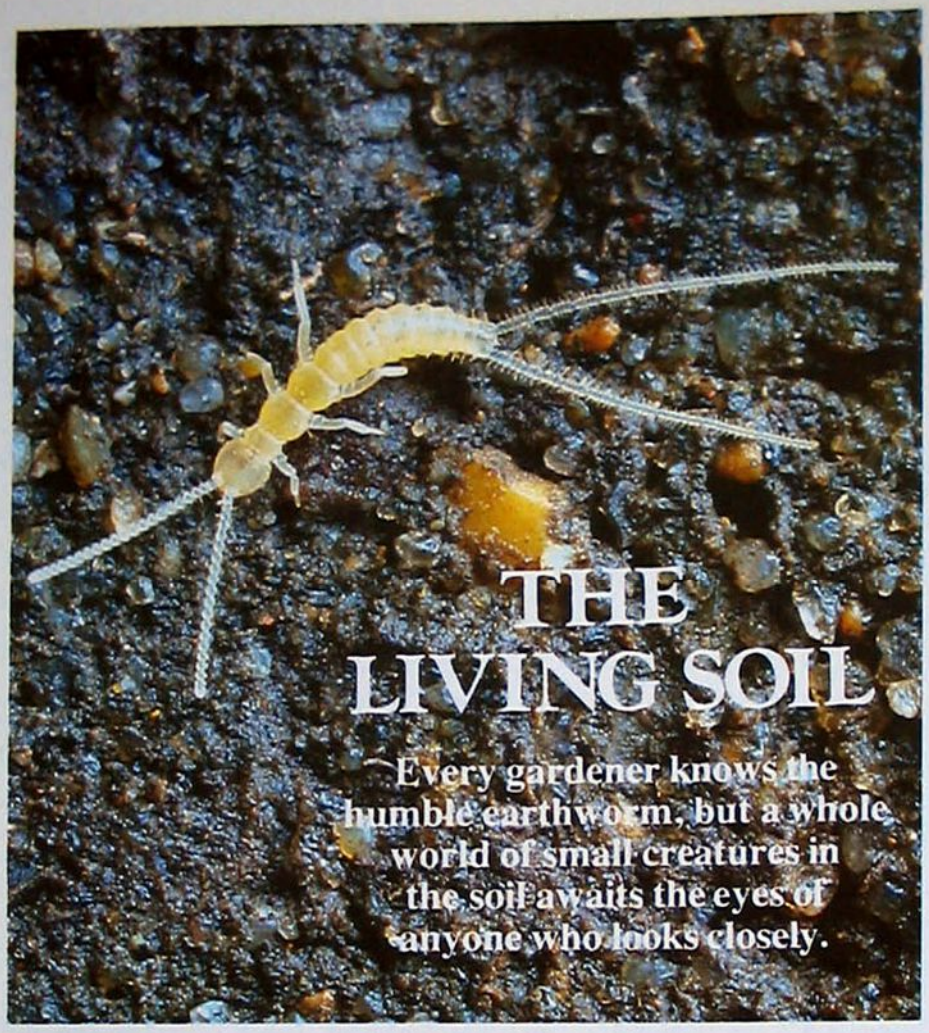
Nesting adult jays are secretive, and the nestlings are also fairly quiet, even when being fed – you may hear a few squeaks and squawks if you are close. Even the egg-thieving jay has to keep its nest-site secret from crows, magpies, squirrels and even other jays who rob the nest if they get the chance. Just as small birds mob jays, so for the same reason jays mob their enemies.

Jays spend about three weeks in the nest but are not independent for another two months, so only one brood is raised each year. They can live for several years and some have been known to reach the age of 14. Throughout their lives jays tend to stay in one area, and most fly no more than four miles from their birth place. Very occasionally the British Isles is invaded by hundreds of jays from the Continent if food supplies there fail to support the jay population.

In the past, when Britain was covered in forest, jays were probably numerous and widespread. However, they were persecuted because of their egg-thieving habit, and many trees have been cut down to make way for agriculture, so jays became quite scarce early in this century. Since then they have benefitted from bein unmolested, and from afforestation. Some have spread into suburban areas and city parks, especially those with a good collection of trees such as oak, beech or sweet chestnut, and shrubs.

Above: A pair of jays with their young in a rhododendron bush. Jay nests are small compared with the size of the well grown young, but they are well behaved and accidents are few.

Jay (*Garrulus glandarius*) about 34cm (13½in) from beak to tail; distribution widespread in woodlands of all types, particularly oakwoods, throughout the British Isles apart from northern Scotland. Resident.

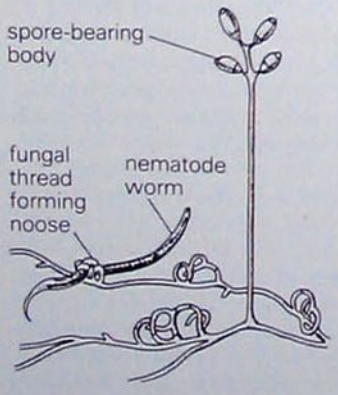


THE LIVING SOIL

Every gardener knows the humble earthworm, but a whole world of small creatures in the soil awaits the eyes of anyone who looks closely.

Above: This two-pronged bristle-tail, *Campodea*, is a soil insect of the group known as the diplura. Up to 5mm ($\frac{1}{5}$in) long, these primitive creatures are close to the ancestral origin of insect life.

How to trap worms



Above: A predatory soil fungus grows loops on its spreading threads (mycelium). When a nematode trespasses into one of these loops, the thread swells and tightens on to the worm. New threads grow into the worm and digest its tissues.

Soil is a complex mixture of mineral particles – derived from the underlying rocks – and organic matter. There are also variable amounts of water and air in the spaces between the solid material. The organic content consists of both plant and animal matter and includes living organisms as well as dead and decaying ones.

These living things are vital components, playing a part in the very formation of the soil and not simply using it as a home. Plant roots, for example, penetrate cracks and help to break down the rocks, while the hordes of bacteria and other micro-organisms are responsible for the formation of humus. Humus is a jelly-like substance, produced by decay, which binds together the mineral particles. This is what causes the crumb-like structure that makes a good mature soil easy for the gardener to work with. The micro-organisms also play an essential role in recycling plant nutrients – releasing them from dead material and making them available to the roots again.

Apart from the burrowing moles, the largest permanent inhabitants of our soils are the earthworms, of which Darwin once wrote: 'It may be doubted whether there are any other animals which have played such an important part in the history of the world as these lowly organised creatures'. Darwin was, of course, referring to the worms' role as ploughmen. Their activity (see page 637) counteracts the downward movement of soil minerals dissolved in the rain water and brings the minerals back to the main zone of plant roots.

Earthworms do not feed entirely below ground: on damp nights they emerge from their burrows and nibble dead leaves on the surface. They often drag the leaves back into their burrows, thus further enriching the soil.

Other reasonably large creatures that make their homes in the soil include centipedes, millipedes, slugs, and ants. All of these animals are regularly seen by the gardener while turning his soil, but let us look for a while at those organisms which the gardener does *not* normally see – the minute and the microscopic beings which have to be looked for with a lens or even a microscope.

Agents of decay The most numerous organisms in the soil are the bacteria – microscopic particles of life which are concerned primarily with the breakdown or decay of dead material. They cause chemical changes in the material and release food and energy for their own use. Many of the simpler substances released during the process can be taken up by plant roots. Without bacteria, little decay would occur and after a while there would be little food for the plants. Life would gradually grind to a halt.

Most of the soil bacteria are rod-shaped organisms between one and three microns in length. One micron is 1/1000 of a millimetre; to get some idea of the real size of the bacteria it has been estimated that a quarter of a million of them could sit on one of the full stops on this page!

Most kinds of bacteria prefer slightly alkaline soils and they are much less common in sandy, acidic soils. Decay is much slower in such places and the partly decayed plant remains build up to form peat.

Microscopic fungi also contribute in no small measure to the breakdown of organic material in the soil, and in woodland environments the toadstools play an important role. The fungal threads penetrate dead leaves and other matter and break down the material of the leaf with digestive juices (enzymes). They attack freshly fallen leaves as well as material that has passed through the bodies of various animals.

The soil fungi are more tolerant of acidic conditions than the bacteria and are relatively more common in acidic soils, but they are equally abundant in neutral and alkaline soils. The size of these fungal threads produces another vivid comparison: if all the minute threads in a gram ($\frac{1}{25}$oz) of soil could be joined together they would stretch for about 100 metres (110 yards).

Although most of the soil fungi are saprophytes, meaning that they feed on dead matter, some of them are parasites, attacking living roots and small animals. A few are even predatory, actively trapping small nematode worms, as the diagram shows.

Single-celled animals The protozoans –

microscopic animals whose bodies each consist of just a single cell – are abundant in the pore spaces between the soil particles. There may be many thousands in a gram ($\frac{1}{30}$oz) of soil and they reach their highest populations in the winter when there is plenty of moisture. In dry conditions many of them surround themselves with tough coats and become inactive (the encysted state).

The various species range up to about 40 microns in diameter, with the larger ones living nearer the surface where the pores are larger. The most common types of protozoans in ordinary soils are the *flagellates*, which move through the water film by means of one or two whip-like hairs (flagella).

Although not outnumbered, the flagellates are outweighed by the *amoeboid* protozoans in the soil. With or without hard shells, the amoeboids simply glide over the soil particles. *Ciliate* protozoans, which are clothed with minute hairs (cilia), occur in small numbers and, unlike the other groups, are confined largely to calcareous soils. Most of the protozoans feed on bacteria, although some ingest decaying matter.

The nematodes Nematode worms, which are unrelated to the earthworms, are abundant in almost every habitat, including the sea and the soil and the bodies of other animals. The astonishing thing about them is their numbers. Some 20 million of these worms may live under one square metre (1.2 square yards) of grassland, almost all of them in the top 10cm (4in). Like other animals, they are less common in cultivated soils because the continual removal of crops prevents the accumulation of food materials.

Although abundant, soil nematodes are rarely seen because they are so small: few exceed 1.5mm ($\frac{1}{16}$in) in length and they are extremely slender. One of the best ways to find them is to bury a small piece of meat in the soil for a day or two and then look at it under a microscope. It will have attracted large numbers of nematodes. Most of the soil-dwelling species are saprophytes, feeding on dead roots, but a few, including the notorious eel-worms, are serious plant pests.

What the eye can see

Some of the common soil creatures large enough to be seen with the naked eye. Please note that the drawing is not to scale.

1 centipede *Lithobius*
2 ground beetle *Nebria*
3 bristletail *Campodea*
4 moth pupa *Callimorpha*
5 meadow ant *Lasius flavus*
6 wireworm larva *Agriotes*
7 false scorpion *Lamprochernes*

Below: An earthworm begins to make a new burrow in the soil. Earthworms feed mainly by swallowing soil as they push through the ground, and digesting any organic material contained in it. The tunnels which they form play a significant part in the drainage and aeration of the soil. The undigested mineral matter is voided by the worms at or just near the surface, and this replenishes the surface layers with minerals brought up from below.

Mites and springtails Many kinds of arthropods live in the soil, the most abundant being the mites and the springtails. Mites, which are related to the spiders, live in all kinds of soil and are especially common in woodlands where there is plenty of leaf litter. Most of them feed on rotting leaves and fungal threads. Some mites are predators of protozoans, nematodes, and springtails. Ranging from 0.1mm ($\frac{1}{250}$in) to 2mm ($\frac{5}{64}$in) in length, the soil mite's body is generally globular and black or brown. It is often of bizarre appearance.

The springtails are primitive insects – some biologists now doubt if they ought to be counted as insects – which get their name because most species have a forked springing organ at the hind end. When disturbed, a springtail releases its spring and leaps rapidly forward. Most springtails have cylindrical bodies up to 5mm ($\frac{1}{5}$in) long and they are most common in leaf litter on the soil surface. They feed on almost any kind of dead matter, together with fungal spores and threads and pollen grains. Several species live lower down in the soil and their springs are poorly developed or absent altogether.

Food for large animals Mites and springtails are eaten by centipedes and ground beetles and also by the fascinating false scorpions. Various insects, too, live in the soil, some at each stage in the life cycle. There are pupae of many kinds, larvae such as the wireworm, and ants and beetles in the adult phase. These are thus the next link up in the food chain that connects the truly microscopic world of the soil and the visible world of the living countryside.

WETLAND FLOWERS

From summer to late autumn, ponds, ditches and streams abound with masses of colourful and varied plant life – including some species which are more familiar in gardens and parks.

The luxuriant growth of marsh plants proves that they are suited to their environment, and are able to obtain a good supply of moisture and mineral salts. The marsh environment is rather special, because of the low amount of oxygen in the soil, as there is water rather than air between the soil particles. Certain species – such as the bur-marigolds – have compensated for this, in a variety of ways.

Trifid bur-marigold is an annual with branched, purplish-red stems and large 3-lobed leaves (hence the name 'trifid' meaning cleft into three). The spongy internal structure of the stem contains aerating tissue, which compensates for the lack of oxygen available from the soil, by storing the available oxygen in the air spaces. The brownish-yellow flower heads are about 2cm (¾in) across, and are surrounded by two rows of bracts, the outer ones being green and leaf-like, and the inner ones brownish-yellow. Although a member of the daisy family, the small, dry fruits are not typical, as they are not covered with hairs, but have two or three barbed bristles instead. When animals or people brush by the plant, the fruits catch on to their fur, or their clothes, and are dispersed in this way, falling to the ground some way from the parent plant.

Nodding bur-marigold has thicker stems and undivided leaves with numerous teeth, but is adapted to wetland life in the same way as the trifid bur-marigold. The flower heads have different forms, some have broad yellow rays, and others do not. The name relates to the way in which the flower heads move easily in the slightest breeze.

Rhizomes In the swampy part of a pond, the ground is submerged at all except the driest times of the year. This is the home of tall plants, that have developed long, creeping rhizomes. These rhizomes anchor the plants, and spread under the mud, allowing them to overwinter and produce an abundance of new plants in the spring, ultimately crowding out other species.

Rushes and reeds typically have rhizomes, as does the common water plantain, which often forms large masses in and around ponds. Its thick, tuberous rhizome gives it a firm hold in the mud, and it is also capable of growing in salt marshes. The leaves grow from the base, but have long stems which hold them above the water level. The whitish, or pinkish-white, flowers have three sepals and three petals, and open only in the afternoon. The unusually shaped one-seeded fruit has a spongy wall, which traps the air, so making the fruit buoyant and helping its dispersal.

Balsams Other wetland plants that have ensured their survival, and indeed increased their numbers by their specially adapted methods of seed dispersal, are members of the Balsam family. Indian balsam, or Himalayan balsam, was introduced to Britain in 1839 from Asia; within 60 years it had become naturalised in many areas, having escaped from the greenhouses where it was originally kept. Its succulent hollow stems and the midribs of the green lance-shaped leaves are reddish. The flowers vary in colour from white and pale pink to a deep rose pink. The plant is often called 'policeman's helmet' because of the shape of the flower, or 'jumping Jack' because of the way in which the ripe seed capsule explodes, due to the tensions set up in the fleshy fruit wall. The 4-12 seeds in a capsule may be thrown as far as 180cm (6ft), a medium-sized plant producing as many as 800 seeds.

Yellow balsam or touch-me-not, is a much rarer and smaller annual. It has succulent stems and swollen nodes (the point at which

Above: The common teasel, despite its prickly appearance, is very attractive to bees.

Right: **Small teasel** (*Dipsacus pilosus*) flowers Aug-Sept in damp woods and ditches. Ht 70cm (28in).

Centre: **Common water plantain** (*Alisma plantago-aquatica*) flowers June-Aug on mud, in or beside water. Ht 60cm (24in).

Above right: **Michaelmas daisy** (*Aster novi-belgii*) flowers Sept-Oct on banks and wasteland. Ht 80cm (31in).

Above centre: **Trifid bur-marigold** (*Bidens tripartita*) flowers July-Sept by ponds, streams and lakes. Ht 35cm (14in).

Above, far right: **Nodding bur-marigold** (*Bidens cernua*) flowers July-Sept by ponds, streams, and in marshes. Ht 35cm (14in).

the leaf appears on the stem). The bright yellow flowers have small brownish or orange spots in the throat.

Hemlock, a member of the carrot family, is a poisonous plant growing in damp areas. All parts of the plant are poisonous, especially the young leaves (which resemble parsley), and the unripe fruits. The ten wavy, ribbed seeds are similar to those of anise or caraway, and the roots are parsnip-like. If you eat hemlock by mistake, respiratory problems or death by paralysis can result.

Usually classed as a biennial, hemlock over-winters as a rosette of the parsley-like leaves. In the summer it bears a flat-topped, creamy white mass of blooms. The smooth, hollow flower stems have dark purple spots on them and the whole plant has an unpleasant smell.

Garden escapes Some species of wetland plants such as golden rod and Michaelmas daisy, were originally garden plants, or are actually cultivated.

Canadian golden rod was introduced from North America by John Tradescant in 1648. It is an extremely invasive garden escape, and has such a mass of densely packed roots that nothing can survive among them. The lance-shaped toothed leaves are pubescent (covered with fine short hairs) on the underside. The mass of golden yellow flowers provide good bee pasturage, especially in late autumn.

The Michaelmas daisy is another member

Michaelmas daisy

Nodding bur-marigold

Trifid bur-marigold

Below: Touch-me-not balsam has wide-mouthed flowers, which attract bees. They disappear into the flower to take nectar, returning dusted with pollen.

Small teasel

Common water plantain

of the daisy family, like the bur-marigold and golden rod. It is mainly a garden escape and is found in all colours and sizes, since plant breeders have produced many different varieties from the original violet form – introduced in 1710 from North America.

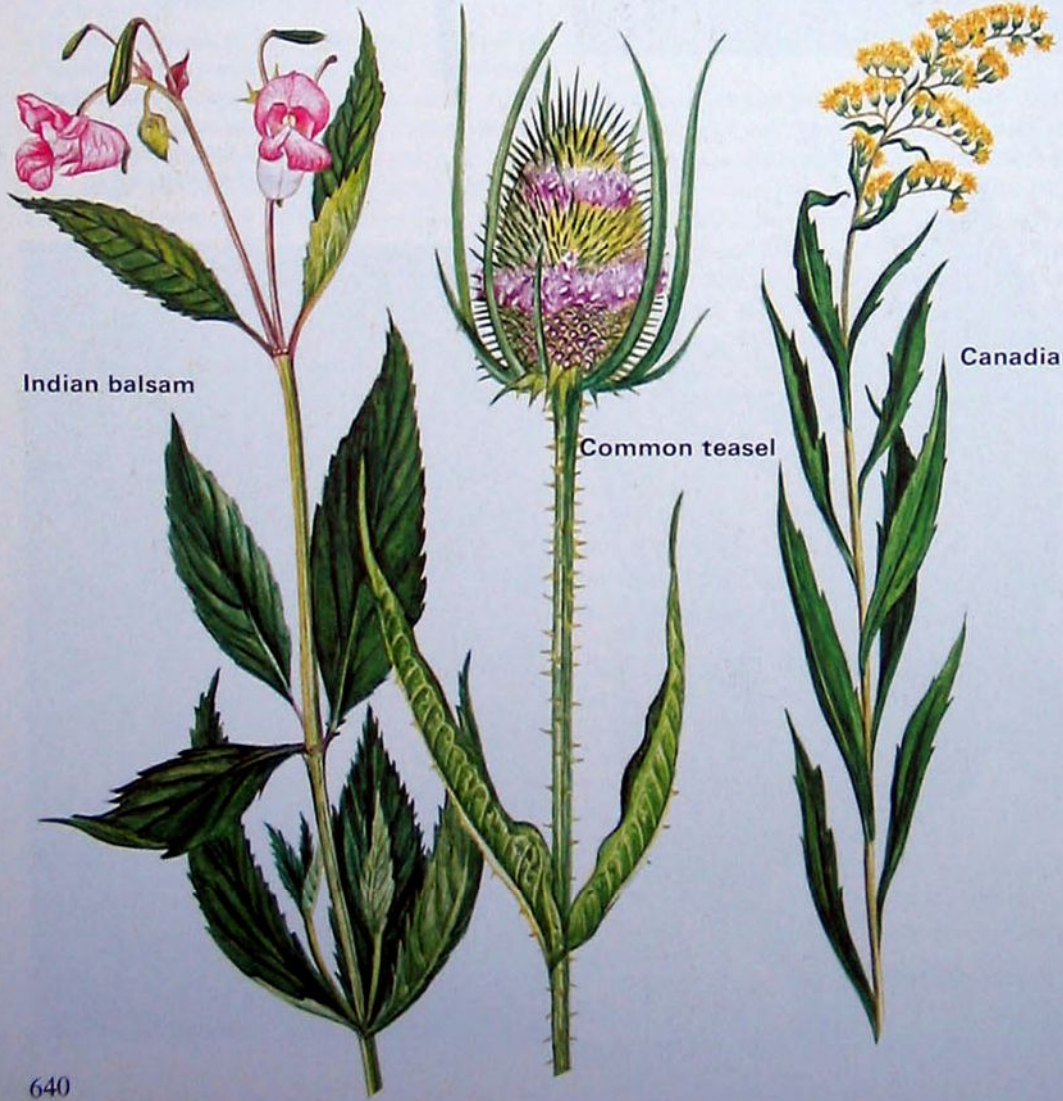
Fullers teasel is a cultivated biennial with an upright ribbed stem, armed with short prickles. The opposite toothed leaves are sessile (without a stalk), and a cavity is formed between them and the flower stem in which dew and rainwater collect. Possibly some is absorbed by the plant, but more likely it forms an impassable barrier for ants, which are nectar thieves.

The pale mauve flowers with their prickly bracts are borne in a cone-shaped head. They open a few at a time, from the bottom of the head upwards. The dried, fruiting heads with their stiff, hooked bracts are used in the wool trade to raise the nap of woollen cloth.

The common teasel is the non-cultivated form of fuller's teasel. They differ only in that the seed head spines are straight and longer in the wild form, making them flexible and unsuitable for combing cloth.

The small teasel is a hairy biennial, forming a rosette of long-stalked basal leaves. The small white flowers with their dark violet anthers are borne in a roundish head, and even the fruit is hairy.

Above: Hemlock (*Conium maculatum*) produced the poison drunk by Socrates, the Greek philosopher, sentenced to death in 399BC. The plant may grow up to 210cm (84in) by streams and road sides.



Left: **Canadian golden rod** (*Solidago canadensis*) flowers Aug-Oct on wasteland. Ht 150cm (58in).

Centre: **Common teasel** (*Dipsacus fullonum*) flowers July-Aug on banks of streams, roadsides. Ht 125cm (50in).

Far left: **Indian balsam** (*Impatiens glandulifera*) flowers July-Oct on river banks and wasteland. Common in N and W England and Wales. Ht 150cm (58in).

The sweet chestnut is often the last tree in the British Isles to produce flowers—they do not appear until July or even later.

SUPERB SWEET CHESTNUTS

The sweet chestnut is a large, handsome tree with fine leaves and flowers, and distinctive twisting bark. But its crowning glory is its masses of shiny dark brown autumn fruits.

We probably have the Romans to thank for introducing the sweet chestnut to the British Isles. It is a native of Asia Minor and eastern Mediterranean countries such as Greece and Yugoslavia. The Romans spread it throughout Europe because the nuts were an important source of food to them. The first evidence of the presence of sweet chestnut in Britain is as charcoal fragments excavated from sites of Roman forts and villas. It does not readily establish itself in the wild and most of the specimens you see have been planted.

The sweet chestnut is not related to the horse chestnut, and it would be difficult to confuse the two: in fact, it belongs to the same family as the oak and beech, and rivals

them in grandeur. It grows up to become a massive tree reaching 30m (100ft) high, its huge trunk extending right up into the crown and sending out contorted limbs to form a broad leafy dome.

The sweet chestnut does best on deep, well-drained soils but tends to avoid chalk and limestone. It is most abundant in south-eastern England but it is widely distributed elsewhere, although it is less common in northern England, Scotland and Ireland. It can be found in woods and plantations and has also been widely planted as an ornamental tree in parks and gardens.

The winter twigs are reddish-brown and bear plump buds, about 5mm (¼in) long, set on little ledges spaced rather irregularly along the shaft of the twig. The tree breaks into leaf towards the end of April or early in May. The fully expanded leaves are 10-25cm (4-10in) long and a rich glossy green. A short leaf stalk supports the spear-shaped leaf blade, the edges of which are cut into long teeth where the prominent veins reach the leaf margin.

Flowers Both male and female flowers are set on dangling catkins up to 15cm (6in) long, which sprout from the base of the leaf stalks on the younger shoots. The yellow male flowers, consisting of a dense tuft of stamens, are much more numerous than the females which are confined to the upper part of the catkin near where it joins the shoot. The greenish female flowers are in groups of three set in a small prickly collar (cupule). Although wind pollination does take place, the pleasant scent from the catkins attracts insects which collect and feed on the pollen, some of which they unwittingly transfer to the female flowers.

Above: **Sweet chestnut** (*Castanea sativa*). Deciduous, introduced, grows to 30m (100ft) throughout the British Isles, lives up to 500 years, sometimes longer. Flowers July, fruits Oct.

Below: The male flowers of the sweet chestnut are more conspicuous than the female flowers which grow on the upper part of the catkin.

Glossy fruits After fertilisation the cupule grows around the ovary in which the seeds develop and forms the familiar green 'hedgehog' case. During October, when the nuts are ripe, the spiny coat splits open, the four lobes peel back, revealing up to three glossy brown nuts packed snugly inside. The nuts are roughly triangular in shape, flattened on the side which lies next to another nut. A tuft of silvery hairs at the point indicates the remains of the stigmas.

The sweet chestnut, with its exceptionally large seeds, cannot be dispersed by the wind or by many animals. However, some animals – notably squirrels and jays – collect and bury them as an insurance against winter shortages of other fruits. Because most animal memories

Right: The most widely used chestnut timber comes from coppiced plantations; there are particularly productive areas in the Weald of Kent and Sussex. These are still cut regularly every 12-14 years to provide stacks of posts, piles and poles. Because sweet chestnut wood splits easily, the poles are cleft into sections which are wired together to make cheap, easily handled fences. In this plantation oak standards are growing in the distance. Pure coppiced sweet chestnut plantations are less hospitable to other forms of wildlife because the leaves cast a deep shade.

Opposite: The bole of a sweet chestnut tree. When young the bark is smooth and brown, but with age it turns greyish and its surface cracks into deep longitudinal fissures which develop a spiral twist up the trunk. This gives the impression that the tree has been slowly twisting as it grows.

Above: Sweet chestnut seeds are well protected in spiny containers. Sadly, British sweet chestnuts rarely produce a generous crop of nuts because our climate is not warm enough. Even though they are small compared with those in the shops which are imported from Spain and Italy, they are still delicious to eat roasted.

Left: It is said that the leaves decompose to a compost unrivalled in its fertilising qualities.

are no match for their thriftiness, many caches are not relocated, and so for the sweet chestnut these creatures are important distributors and planters in the wild.

Crunchy golden leaves While the nuts are dropping from the trees the leaves acquire their autumn hues, paling first to yellow and then darkening to gold before dropping. The fallen leaves form a deep carpet beneath the tree and this rustles loudly underfoot because they remain stiff and dry–not soggy and shrivelled like those of so many other trees.

Durable wood Although mature sweet chestnuts yield a large volume of timber, the wood is not as useful as oak because cracks tend to appear during seasoning. This condition, known as 'shakes', severely limits the size of beams or length of planks that can be extracted from the bole. However, the timber is durable out of doors and even underground–it has been used for making coffins.

Long life The sweet chestnut is one of the few European trees that matches the oak for longevity. Its normal span is about 500 years but many specimens exceed this. In old age the tree becomes grotesquely misshapen with a gigantic gnarled trunk and huge twisted limbs so heavy they may touch the ground.

An enormous sweet chestnut grows in the grounds of Canford School, Dorset. The tree's bole is 13m (44ft) in circumference–the greatest girth of any living tree in Britain.

RARE VISITORS TO OUR WATERS

The British Isles are well placed to receive some rare fishy visitors. Strange and unusual fish strand themselves on our coastline or are spotted swimming in our seas thousands of miles from their homes in the Mediterranean or Atlantic.

One February evening in 1981 Mr Robert Wood was exercising his dog Prince on the shore at Whitby in Yorkshire, when Prince made a dash at something in the waves. Investigating, Mr Wood found a fish of such huge proportions and such an unusual shape that he could scarcely believe his eyes. He saw two goblet-sized, silvery eyes in a wafer-thin head, and a long silvery body that stretched into the surf for yards. Prince and Mr Wood had found an oar fish, one of the rare fishes that are washed up from time to time on to Britain's coastline.

A unique position As the British Isles are positioned on the shallow waters of the continental shelf which juts in to the Atlantic for many miles from the European mainland, many unusual fish and other sea animals stray into our waters. In fact, Britain is in a unique position, because its islands lie at the boundary of two different marine faunas, the boreal (from the Latin name for the north wind) and the Lusitanian (from the Latin name for the area now known as Spain and Portugal).

The fish that come from these two faunal areas play a large part in the wealth of our seas, for the herring and the cod are boreal species, their ranges extending as far north as the Arctic circle, while fishes like the pilchard and the sole are Lusitanian, frequenting the Mediterranean and waters around North Africa, but not extending much further north than Britain. Unusual fishes from both areas turn up from time to time on our coasts, as do fish from the open tropical Atlantic.

Ray's bream, so named because it was first described by the great English naturalist John Ray from a specimen found in 1681, is a typical example of a Lusitanian rarity. Abundant off the Portuguese coast, where it is fished commercially both by trawlers and on lines, it appears to make a northward migration each year in spring. In most years the schools only travel as far as Biscay, but every now and then a 'Ray's bream year' starts and they are caught by trawlers off the south western coast of Ireland in June and July. By August to September, the schools

Below: Apart from being ensnared sometimes in fishing nests, often the only indication we have of rare fish in our waters is when they are washed up and stranded on beaches, like this shallow south Cornish beach. This part of Cornwall is one of the areas where the Mako shark is found.

are west of the Hebrides and around October they appear between the Orkneys and Shetland. Possibly at this time some of them turn back towards the south, but others move eastwards into the northern North Sea. Here the water cools with the approaching winter, and so the schools move southwards. Then the North Sea turns into an enormous trap, for the further south they travel the shallower the water becomes, and as the year progresses, the water becomes increasingly colder. This cool, shallow water leaves the Ray's bream disorientated and they strand themselves in large numbers on the east coast. In November, the strandings are mostly in the Moray Firth, but by December the fish are found on the Northumberland and Yorkshire coasts, and in January on the Norfolk coast.

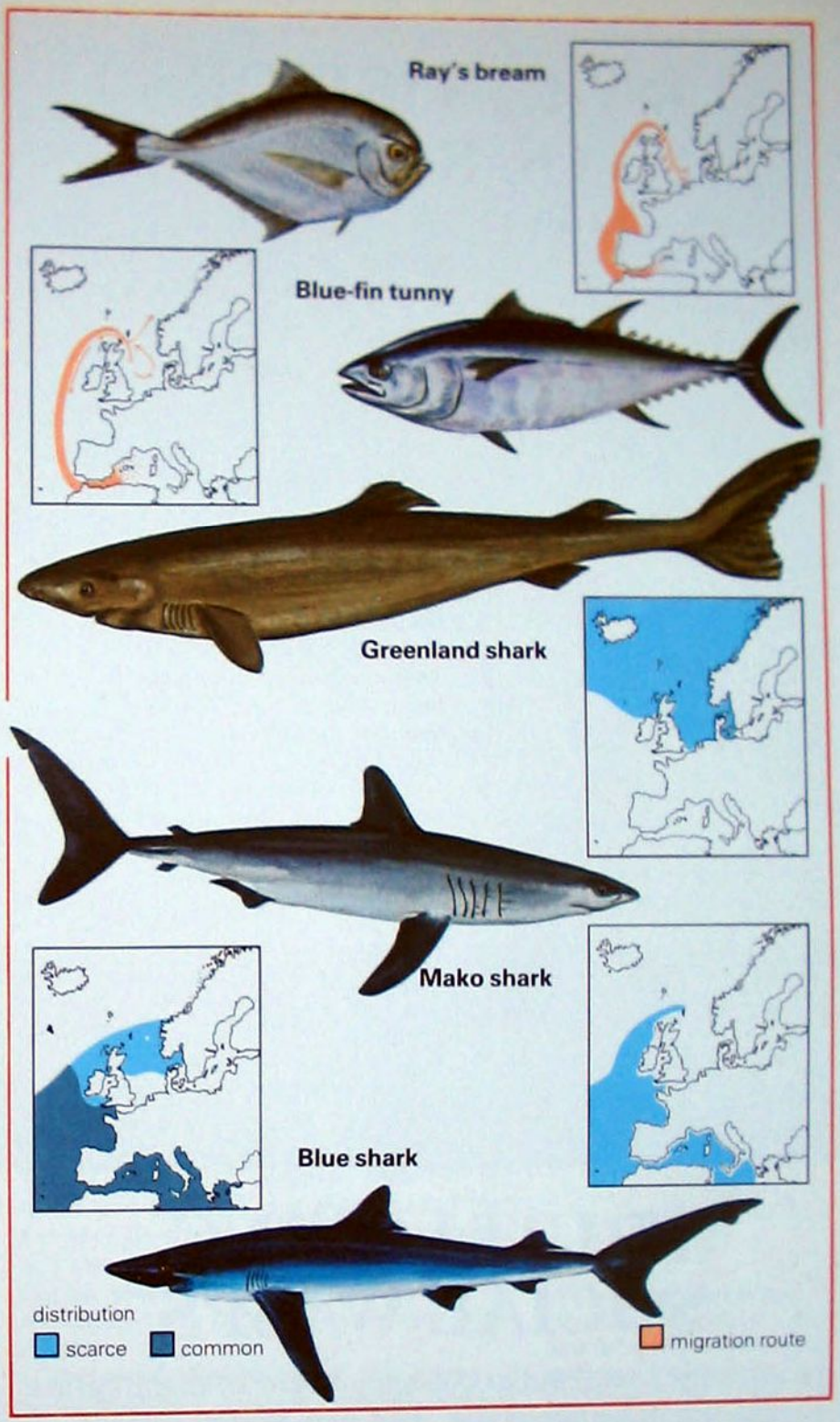
Huge numbers of fish take part in these migrations; in 1978 hundreds were reported stranded on the east coast. It is not certain why these migrations take place – possibly the fish are simply swept along by currents that are stronger than usual. Another possibility is that for some reason population numbers may be higher than usual in some years and the fish then spread outwards in search of living space. Whatever the reason, Ray's bream are a relatively frequent sight on the east coast in certain years only; in most years very few are caught or found.

Blue-fin tunny The bream's migration is matched by that of the blue-fin tunny which regularly moves northwards in schools from its Mediterranean breeding grounds to feed in the northern North Sea and the Norwegian Sea. These powerful swimmers mostly return southwards through the Atlantic before winter. Some are caught by fishermen, but today these are mostly 'small' fish, weighing 91kg (200lb), much smaller than the 362kg (800lb) fish that were often captured in the North Sea in the 1930s.

Other tunnies, including bonito and skipjack tuna, are found more rarely, but the rarest of all is the huge yellow-fin tuna. In 1972, this was seen in shallow water off the coast of North Wales, before stranding itself in a tidal pool at Portmeirion near Port Madoc in Cardigan Bay. A rather imposing fish, measuring over 1.5m (5ft) in length, this is the only record of its occurrence in the seas of northern Europe.

These tunnies, surface-living inhabitants of the tropical and warm temperate Altantic Ocean, migrate regularly. They appear on our shores when they have strayed too far to the north, very often stranding themselves once they get into shallow water.

Shark visitors Not all the rare fish we know of are found stranded. In the 1950s, shark anglers fishing offshore on the southern coast of Cornwall found that the blue shark, hitherto thought to be rare in the Channel, was present in considerable numbers. In subsequent years, over a thousand a year were captured from June to September.



The mako shark has also been recognised off the British coast, although it is very rarely caught. The largest specimen ever taken was a 227kg (500lb) fish off the Eddystone Rock in 1971. These large sharks certainly migrate into the Channel and west of Ireland each summer, but they never come close enough inshore to pose a threat to bathers.

Another even larger shark, the Greenland shark, which can reach a weight of over one tonne is an example of the northern boreal fauna. It is common in the Arctic Ocean, and occurs off Norway and Iceland, but only rarely as far south as Britain. It was best known as a scavenger at whaling stations but has recently become much rarer.

Above: Five species of rare fish that visit British waters occasionally. The maps show the places where they are likely to be found.

FRUIT-LOVING SOCIAL WASPS

In autumn social wasp colonies begin to disintegrate and the old queens die. The new mated queens, however, and the surviving workers, spend their time feeding on ripe fruit and the nectar from late blooming flowers – particularly those of ivy.

Above: A common wasp feeding on a ripe plum in autumn. These insects make themselves a nuisance wherever there is ripe fruit to be had. By contrast, wasp larvae are fed mainly on meat – flies, caterpillars and spiders.

Social wasps live in annual colonies headed by a fertilised female (queen) whose offspring they are. There are seven species in the British Isles, the largest being the hornet which is uncommon and nests in hollow trees. The common, German and red wasps nest underground; the tree and Norwegian wasps choose aerial sites in hollow trees or bushes, while the seventh (lacking workers) is parasitic on the red wasp. The common and German wasps are abundant, and most studies have been made of them, although all have similar life histories. Their bold yellow and black coloration and tapering abdomen make all these insects easy to identify.

Establishing the colony The wasp's year starts with the fertilised queen waking up from hibernation in early spring to seek a suitable nesting site. Common and German wasps look for places such as old mouse holes in banks, but other enclosed spaces such as attics and sheds may be selected. When she has found a site, the queen starts to build her nest, laying eggs in the cells as she builds.

The first eggs hatch five to six days after nest-building starts and the queen then spends part of the day bringing back nectar and insects she has captured to feed the young larvae. The larvae take about two weeeks to become full grown, when they spin a silk cap and lining to the cell. During their feeding stage they do not excrete any waste matter, but this is now done and the mass of waste is

Common wasps

Male common wasp (*Vespula vulgaris*). Maximum length is 16mm ($\frac{5}{8}$in).

Queen common wasp: queens reach a length of about 18mm ($\frac{3}{4}$in).

Worker common wasp: smaller than queen and drone at 9-14mm ($\frac{3}{8}$-$\frac{1}{2}$in).

Below: German and common wasps feeding on a windfall apple. You can distinguish the two species by the markings on the abdomen. The common wasp has a broad black triangle near the base, while the German wasp has a row of heavy black diamonds in the centre.
Although wasps are unpopular because they sting, damage fruit and spoil picnics, they are valuable to man because they prey on flies and other insect pests.

placed at the bottom of the cells, filling them up so that each cell can only be used two or three times. The larvae change to pupae and emerge as adult wasps after a further ten days or so, by which time the queen has increased the comb to 20 or 30 cells.

The young wasps at this time of the year are all small females (workers) and are subordinate to the queen, their mother. They gradually take over all nest operations, leaving the queen solely responsible for egg-laying. Later in the year workers lay some eggs, but as they never mate, their eggs are all unfertilised and produce males only. This is the rule in wasps, bees and ants and it seems, in some way not yet understood by scientists, that a mated female is able to decide whether to lay fertilised, female-producing eggs, or unfertilised, male-producing eggs.

As the number of workers increases, so do the nest size, the number of combs, thickness of the envelope and the number of larvae needing feeding. Ground-nesting wasps also need to enlarge the size of the hole containing the nest by carrying away balls of earth.

Foraging and feeding The main food of the adult wasps is carbohydrate in the form of nectar, but other sources include honeydew excreted by aphids, jam and ripe fruit, and they also rob honey bee hives of honey. Their mouthparts are adapted to biting, licking and chewing.

The adults need carbohydrates as a ready source of energy to maintain their active existence. The larvae are also fed on carbohydrate, but their principal food is flesh in the form of masticated bodies of other insects –and also meat from butchers' shops! The dominant prey is flies, caterpillars and spiders.

When wasps are searching for prey they move much faster than usual, flying to hedgerows and other places that are frequented by insects. It seems that sight is the most important sense in finding prey. Once sighted, the wasp pounces vigorously and kills by biting into the victim's neck, often causing decapitation. It then bites off the legs and wings before carrying the prey back to the nest. By preference wasps choose prey that is resting. They sometimes use their stings on large prey, or on bees.

Worker wasps have three main foraging tasks–bringing back pulp for building, collecting sugary liquids and capturing prey. The length of their adult life varies from two to four weeks. Compared with honey bees, wasps have little ability to pass on information having nothing to compare with the bee dance (see page 389) for example, but they are very flexible in their foraging activities and soon learn the best places to seek prey. Larvae indicate hunger to the workers by scratching their cell walls with their mandibles.

The social organisation of the colony is maintained by a constant exchange of food

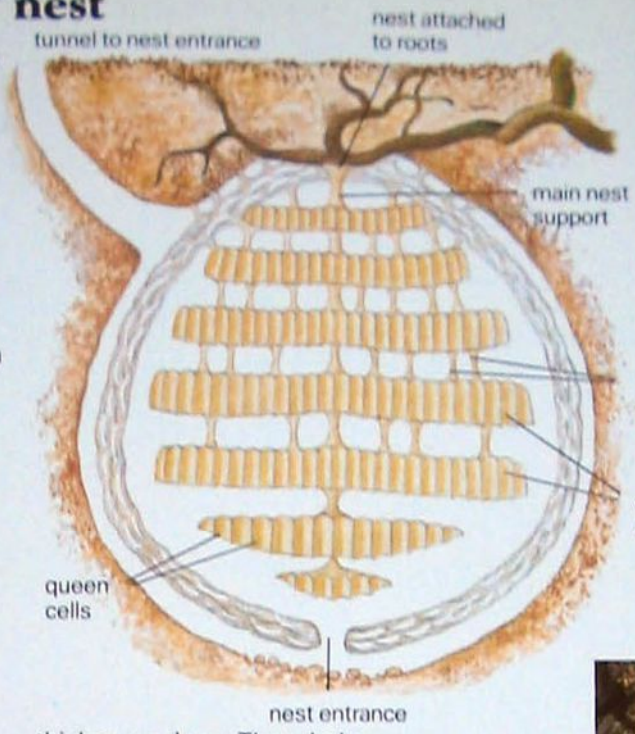
Worker German wasp (*Vespula germanica*). Smaller than common wasp; reaches a length of 12-15mm ($\frac{1}{2}$-$\frac{5}{8}$in).

Worker red wasp (*Vespula rufa*). Same size as the German wasp. Makes its nest underground.

Worker tree wasp (*Dolichovespula sylvestris*). Same size as the German wasp. Nests in trees.

Inside a wasps' nest

A social wasp's nest is made of chewed food mixed with saliva to produce a kind of papier maché. This is laid down in narrow strips to form horizontal combs of hexagonal cells, supported by pillars and surrounded by a paper envelope. The cells open downwards. The common wasp and hornet use rotting wood and make a yellowish-brown, brittle paper; the German and other species use dead but sound wood that produces a grey, more elastic paper. The nests of the common and German wasps grow to about 25cm (10in) in diameter with seven or eight combs and 10,000 cells, though they sometimes grow even larger. A colony of common wasps usually has about 2000-3000 workers. The main spurt of activity takes place in July. The other species make smaller nests 16-21cm (6-7in) in diameter, with only three or four combs and a much thicker envelope. The whole nest hangs from a support such as a root, with the entrance at the bottom. The combs are supported and separated by a central pillar and narrower pillars at intervals.



Above: Nest of common wasp dug up and exposed to show shape and structure. Note the large cells – for queens – at the bottom.

Below: Wasp grubs (larvae) in their cells. The capped cells contain the wasps that are pupating.

among the individuals, known as 'trophallaxis'. Adults continually elicit drops of fluid from larvae and also have mouth to mouth contact with each other. If any of this is prevented, the colony goes into a decline. It seems that the larvae can be stimulated to produce a drop of nutritious fluid which is eagerly sought by the adults. The queen imbibes large quantities which help her to maintain her egg output, and newly emerged adults feed on little else. The amount of the secretion seems to depend on the amount of fluid or food that the larva has had.

Adult wasps stimulate one another to pass food from their crops by stroking with their antennae. This is the way the queen obtains her food, supplemented by larval secretions. These exchanges probably contribute to colony odour, enabling members to recognise each other. The presence of a queen ensures a contented, normal colony; her removal results in changes of behaviour – for example the workers sit about in groups instead of flying out to forage. This suggests that the queen produces a substance which permeates the entire colony and helps maintain its coherence.

The new queens Later in the season, when the colony is strong, combs of larger cells are built at the bottom of the nest. These are destined to produce new queens; some of the larger cells are also built at the edges of the lowest normal comb. It seems that eggs develop into queens because the larvae have more and better food and are placed in larger cells – male eggs in these cells also produce larger males. Males are produced at the same time as the queens, from unfertilised eggs placed in either type of cell and laid both by the queen and by workers. Males have longer antennae and their sole function is to fertilise the young queens. Each colony produces 1000 or more males and queens.

Mating takes place from late August, the males often congregating on sunny days, but it may occur near the nest without swarming. Following mating, the queen seeks out a hibernation site, often indoors. She does not always hibernate immediately after mating however, and may fly for a further six weeks. A hibernating queen clings on to a support such as a curtain or wooden beam with her mandibles and folds her wings and appendages in a characteristic way. Hibernation sites need to be well-insulated, with moderate humidity.

In late summer with the appearance of the new males and queens, the social organisation of the colony begins to disintegrate, and the old queen dies slowly, after which the workers desert the nest or die, as the males do when the weather gets colder. In the autumn the workers no longer capture prey as there are no larvae to feed, and they spend much of their time eating ripe fruit and nectar. They particularly favour nectar from ivy.

Hover-fly parasites

The space below the nest of a ground-nesting wasp in time becomes a kind of midden or refuse heap, laden with rubbish of all kinds as well as masses of dead larvae and adult wasps. It is a breeding ground for a number of flies, the best-known being hoverflies such as *Volucella pellucens* (below) that bear some resemblance to wasps and seem to enter the nest without being molested by the wasps themselves. Their larvae live in the midden and later on invade the nest to feed on the larvae and pupae within. The adults visit flowers for nectar and pollen.

HARK, HARK, THE LARKS!

The skylark is recognisable for its sustained song as it flies in a broad sweep high over open ground. The rarer woodlark sings as it spirals upwards, its distinctive song a rich and beautiful melody.

The woodlark and skylark have very different distributions within the British Isles. To see a woodlark on any but a few lowland heaths in southern England is enough to turn an ordinary day's bird-watching into a red-letter day. On the other hand, the skylark is the characteristic bird of open country and, according to the BTO's field-work completed in 1972, it is undoubtedly the most widespread breeding bird in Britain and Ireland.

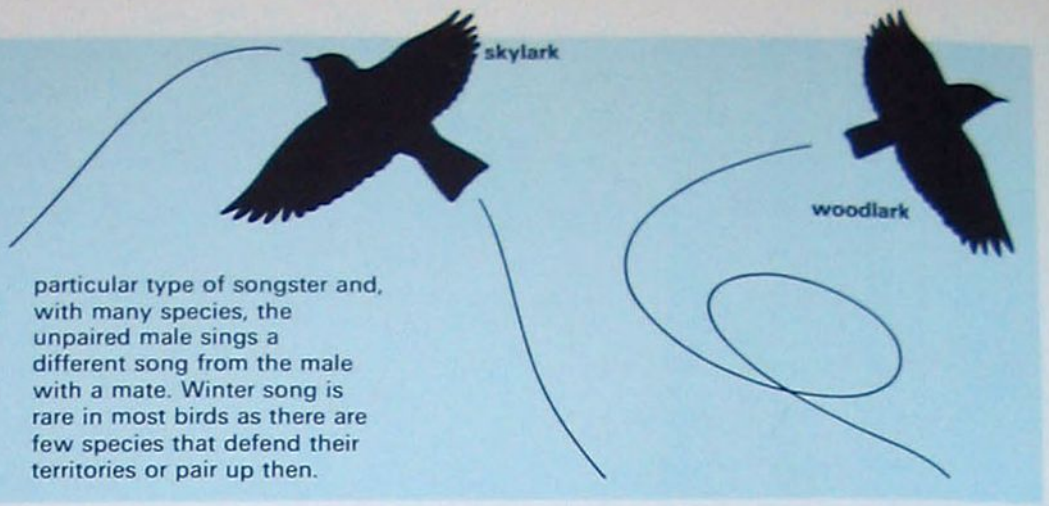
The skylark's brown plumage serves as a good camouflage for the bird when it is in the open ground it prefers. Unlike most birds, it sings on the wing, marking out its territory on the ground by circling and singing above it. Its song, which includes mimicry of the notes

Woodlarks are rare birds and the total British population may now number only 150-200 pairs. They are specially protected under the first schedule of the Bird Protection Acts; they only breed in dry areas of heathlands or downlands.

Woodlark (*Lullula arborea*), 15cm (6in) long from beak to tail.
Distribution map page 651.
Migrant.

Bird song

The skylark (right) is famed for its habit of soaring high in the sky, rising and descending repeatedly, all the time pouring out a torrent of song. The woodlark (far right) has a circular song-flight and its song is mellow-toned. Both birds also sing from song-posts. A singing bird is advertising itself. It is proclaiming that it owns a territory and warning its neighbours that it is around. Birds also sing to find a mate. Females may be attracted to a particular type of songster and, with many species, the unpaired male sings a different song from the male with a mate. Winter song is rare in most birds as there are few species that defend their territories or pair up then.



of other birds, is a familiar and attractive feature of the countryside for much of the year. It is very loud, and a bird which seems to be singing overhead often turns out to be a mere speck in the sky. One singing bird stimulates another: as dawn breaks over an area of downland where there are no larks singing, all the birds start to sing within the space of one minute, producing a complete wall of sound. This habit of singing in flight is crucial to the skylark's ability to colonize truly open areas: other species of open ground are often unable to breed if there are no song-posts from which to sing and mark their territories.

The skylark can often be seen busily pecking at apparently bare earth. For most of the year it is mainly vegetarian, feeding on tiny weed seeds that lie dormant in the ground. At other times, particularly spring when the seeds are beginning to grow, it may feed on the nutritious growing points of the young plants. Because of modern agricultural techniques, this has turned the bird into a pest: in the past sugar-beet growers planted the seeds densely in rows, later thinning them. Today farmers have taken to sowing single encapsulated seeds exactly where they want the plants to grow. However, the skylarks may then peck the growing point from the young seedling and spoil the farmer's carefully planned harvest.

Below: The eggs of the skylark hatch after 11 days incubation, and the young remain in the nest for 8-10 days. Then, although they are not yet able to fly, they leave it and move around in the grass. At this stage their bodies are well feathered, but their wings are not yet grown and they still retain some down.

Three broods Skylark pairs form during early spring. You often see a singing bird at the end of its song-flight drop to the ground and display to another bird already standing there. The nest is always on the ground, often built into an existing depression such as the hoof-print of a cow. Indeed, some bird-watchers have encouraged skylarks to nest by forming hollows with their heels in firmly rolled grounds.

The nest cup is built of coarse grass and roots lined with fine grass and sometimes hair. The eggs, generally three or four to the clutch, are whitish and thickly speckled all over with olive or brownish markings. The young, which hatch after 11 days incubation, are able to fly at about three weeks old and start to behave more like their parents. They are still easily distinguishable from their parents because of their more blotched and softer brown plumage. A single pair may raise three broods during the breeding season from April to July.

New plumage The only period when skylark song is absent is during the moult in August and early September when young and old alike renew their plumage completely. The young birds lose their soft blotchy plumage and the adults the old, bleached and tattered feathers they have worn for the whole of the preceding year. When the moult is complete, juveniles and adults are indistinguishable. The sexes always look alike, at least to human eyes, but the males average about 6% bigger

than the females.

During autumn and winter skylarks often join together in flocks which include young birds and immigrants from further afield. For much of the winter, territorial males can be heard singing in all but the bleakest areas. Only during the period of least daylight does song almost cease – presumably since the full hours of daylight are needed to find food.

Woodlark There is a marked contrast between the widely distributed and familiar skylark and the rare and local woodlark which is limited to southern Britain. Although the woodlark is now a rare bird it was common at the beginning of the 19th century. It suffered particularly during two cold winters in the early 1960s. During the 1970s there were many years when none was recorded but there may now be one or two territories occupied each year. Indeed, since the BTO's 1972 study the distribution of the species has contracted, with the outlying populations in parts of Wales and Lincolnshire in particular diminishing still further.

Woodlarks breed only in dry areas of heathland and downland. They need short grass areas for feeding, longer vegetation for nesting and some vantage points such as trees, bushes or even fence posts for song-posts. The woodlark's song is its most distinguished attribute – few birds have such a melodious and distinctive series of flowing notes which may continue, uninterrupted, for 15 or 20 minutes at a time.

The woodlark looks fairly similar to the skylark but it has a very short tail, (don't confuse it with the tailless, moulting skylark of late summer), a conspicuous dark brown and white mark on the leading edge of the closed wing, and a rather finer bill than the skylark.

One problem with such a rare species is that many inexperienced bird-watchers report tree pipits as woodlarks. Tree pipits inhabit a similar habitat and have a fairly pleasing song, although it is boring and repetitive when compared with a genuine woodlark. Their song flights are also quite similar for although the woodlark commonly sings from a song-post, it also sings during its looping display flight.

Breeding woodlarks are often found in traditional sites after intervals of several years. This may mean that breeding birds had been overlooked in the meantime, but it is much more likely to indicate that woodlarks look for a particular sort of area in which to breed.

The first clutch of eggs, usually three or four, is laid at the end of March or early April and there may be three broods a year. The young birds leave the nest before they can fly and hide singly in the vegetation whilst being cared for by their parents for a further 10-14 days. Both young and old birds moult in late summer and, in European areas where they are more common than in the British Isles, they can often be found in quite large loosely associated flocks on stubble. The song has ceased by this time, but their distinctive liquid call-note of three syllables – 'ti-loo-whit' – and their short tails identify them.

Skylark pie? With the great interest in bird-watching and bird protection in the 1980s it is amazing to record that less than 100 years ago there was a thriving export trade with France in dead skylarks. They were netted on the south downs and shipped across the Channel to be sold in French markets.

Skylark (*Alauda arvensis*), 18cm (7in) long from beak to tail. Distribution map opposite. Resident, winter migrants from northern Europe.

Below: Skylarks always make their nests on the ground. These nestlings are about two weeks old and are well camouflaged with their soft brown plumage.

BEEF CATTLE: OLD AND NEW

The faces of beef cattle peering over a farm hedge or fence is a typical image of the British farming scene. Breeds you can see today range from the ancient Herefords (below) and Highlands to the recently introduced Chianinas and Simmentals.

The beef cattle of the British Isles have undergone a quiet revolution in the past 20 years. Foreign bulls have been imported and crossed with native British breeds to produce a new hybrid that matures earlier—because of a faster growth rate—as well as producing a heavier beast with leaner meat. However, the 15 or more native British beef cattle breeds are all still important; they range in size and appearance from the small, squat, compact Aberdeen Angus to the shaggy, wide-horned Highland.

In contrast to dairy cattle calves, those raised for their meat alone are usually richly fed so they become large and heavy within as short a time as possible. Most beef cattle breeds have thick bodies, short legs and massive hind-quarters.

Dual-purpose breeds In areas that are not appropriate for raising large herds for either beef or milk, cattle that can produce milk and meat are kept. These are called dual-purpose cattle. Until recently they produced less milk than dairy breeds, and meat which was inferior to the beef-only breeds. However, careful selective breeding has produced improved strains of the old native breeds, such as the Red Poll, South Devon and Welsh Black, that compare most favourably with a true dairy cow or a beef cattle breed.

Beef cattle calves are born either in the beef suckler herd or on dairy farms. In both cases the cows have been bred selectively over several generations to suit these very different ways of life. The most important source of beef cattle is the dairy herd. Every cow has to produce a calf in order to come into milk and, overall, equal numbers of heifer calves and bull calves are born.

The bull calves, born in a dairy herd, have no other future but to be reared for beef, except for a few lucky ones with excellent pedigree records, that are selected for rearing as bulls and used for future matings. Most male cattle reared for beef are castrated and then are called steers. Those heifer calves that are not needed for producing milk are diverted into beef production. They are separated from the cow at a few days of age and are bucket-fed with a milk substitute until about five weeks old.

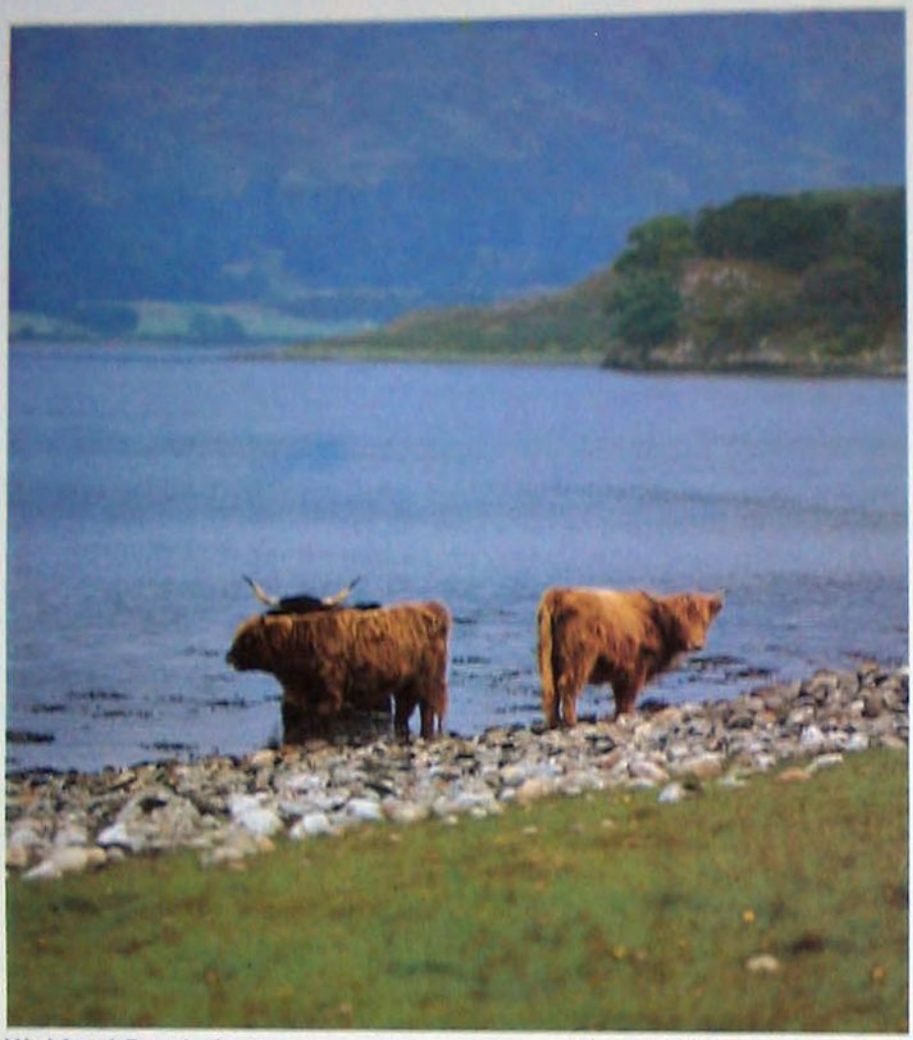
Suckler cows The other main source of beef cattle is that of the suckler cow herd. Beef suckler herds are kept on a wide range of farms. Some herds are reared on lowland farms but the majority are reared on upland farms 150-300m (500-1000ft) above sea level, and mountain farms above 300m (1000ft). Beef suckler cows are usually mated with a beef cattle bull and they calve in the spring or autumn. The calf is reared by its mother (dam) and as one mother cares for one offspring the calf is said to be single-suckled.

The Highland or Kyloe is a native breed of the central and northern Highlands, and the Western Islands of Scotland. With its large, spreading horns and its long, shaggy coat of straight or slightly wavy hair, the animal appears massive. However, it is not as large as it looks, the body being of a medium size only beneath all that fur. A dense undercoat of soft, fine, woolly hair protects it in the exposed surroundings of its home country, where it can subsist on the poorest grazing. An adaptation that helps its survival in bleak environments is the fact that its first stomach (rumen) is larger than other breeds. This allows it to take in a larger amount of roughage and so increases the heat produced through fermentation, giving it built-in central heating.

The Galloway is an old breed of obscure origin. It supposedly takes its name from the

Above: Beef Shorthorn bullocks treading well-worn paths to water. Probably the breed has contributed to the development of the Charolais.

Below: Dun-coloured Galloways grazing at Woodwalton Fen, Cambridgeshire. The breed is adapted to arid and high rainfall environments.



Above: With spreading horns and shaggy coat, unmistakable Highland cattle paddle at the edge of a Scottish seawater loch.

Highland Breed of extreme hardiness. Native to Highlands and Islands of Scotland.
Mature bull 326kg (720lb)

southwest county in Scotland where it was the only breed of cattle to be found at one time. During the 17th and 18th centuries over 20,000 Galloways were sent down the drove roads each year from Scotland to be fattened on richer pastures in England, mainly in East Anglia. This black or dun-coloured, hornless (polled) animal is another hardy breed that can withstand intense winter frosts, as well as very wet areas or even arid conditions. The skin is thick and the coat abundant, consisting of a dense, mossy undercoat with an outer covering of long, fine hair.

A 'Blue-grey' is a popular, efficient crossbred suckler cow resulting from a Galloway cow being crossed with a Whitebred Shorthorn bull. This crossbred is usually found in northern England and southwest Scotland.

The Aberdeen Angus originated in the old local breeds of Angus and Aberdeenshire, where they were known as 'Doddies' and 'Humlies'. Records go back to the middle of the 16th century, when, even then, a proportion of these cattle were black and hornless–characteristics that are now practically fixed in the breed.

The Aberdeen Angus is popular as the heifers calve at a young age and have few calving difficulties, and the calves mature early. This breed gives beef of excellent quality, and in Britain is the cornerstone of Scotch quality beef.

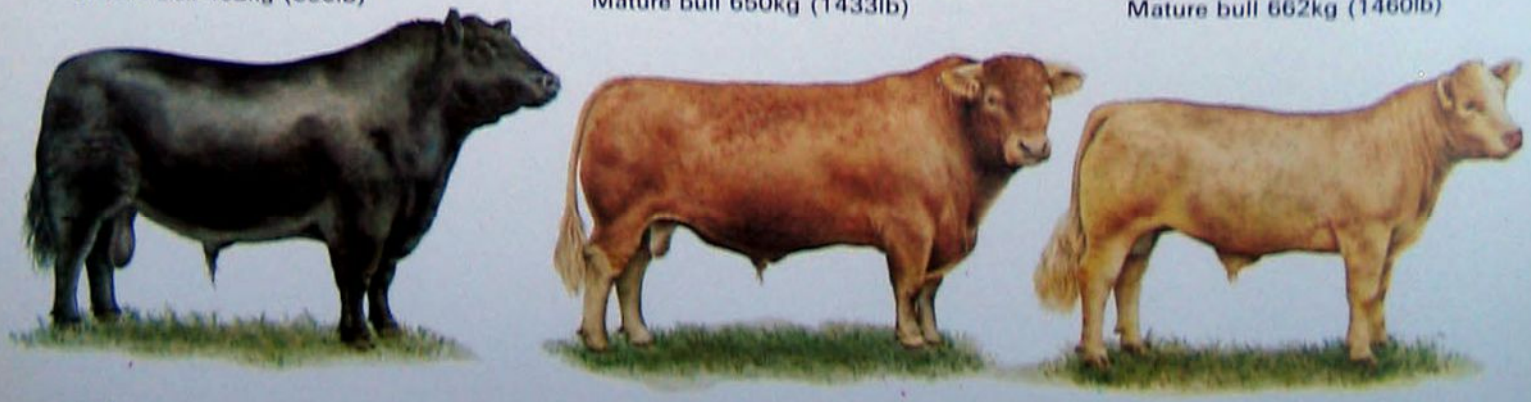
The Hereford was noted for its quality in the county of Herefordshire at the beginning of the 17th century. Then they were acknowledged not only for their beef, but also because with their large, stoutly built, hardy bodies they were excellent for work. Herefords today are generally well suited to being reared and fattened on rich pastures. Pedigree herds can be found on many English and Welsh farms and the breed has become widely spread around the world, having been exported to the United States, Canada, South America and Australia. One reason why Herefords have become one of the world's dominant breeds is that the cattle have proved to be very adaptable to a wide range of climates.

The Shorthorn existed as early as the mid-

Aberdeen Angus World-wide reputation for the production of quality beef.
Mature bull 452kg (996lb)

South Devon Largest native breed developed on rich lowland pastures of southwest England.
Mature bull 650kg (1433lb)

Charolais Young bull. First imported into Britain in 1961. Good quality beef.
Mature bull 662kg (1460lb)



16th century in northeast England and came mainly from Dutch and Scandinavian stock. The breed spread throughout the British Isles and breeders developed different types to suit their needs. Today four breeds are recognised – the Beef Shorthorn, the Dairy Shorthorn, the Northern Dairy Shorthorn, and the Whitebred Shorthorn.

The Beef Shorthorn was developed by Scottish breeders. It is a large animal that matures remarkably early. Its colour can be red, red and white, or roan; a dark roan being the most common.

Welsh Black cattle are believed to have existed in medieval times. The strain we recognise today appears to have come from two types, the North Wales or Anglesey, and the Pembroke or Castlemartin breed of south-western Wales. At the beginning of this century a new breed was produced from the Anglesey and the Castlemartin. The former was more important for beef production while the latter was more of a dairy type. The modern breed is a dual-purpose animal with different emphasis put on the herds depending upon where they are farmed.

The South Devon is Britain's largest native breed of cattle and is found grazing the rich lowland plains in south Decon and Cornwall. Often called 'South Hams' this animal is distinguished from the Devon by its greater size. Also the South Devon is not usually found in the hilly regions of Devonshire where the Devon breed is farmed. A true dual-purpose breed, the short-legged South Devon can reach massive proportions.

The Red Poll of East Anglia was developed from local breeds: the Norfolk Horned, a small, red, compact beef breed, and the dairy Polled Suffolk Dun. The steers fatten early and the beef produced is of good quality. Many dairy herds give excellent yields of good quality milk that compares favourably with a true dairy breed.

Luing cattle have been developed in recent decades by crossing Highland cows with Beef Shorthorn bulls. It is the most important new breed of cattle to have been developed in Britain this century. The breed was evolved on the island of Luing (pronounced Ling) off the west coast of Scotland. The coat colour ranges from red through yellow to white with a series of roan coat patterns. The small cows give birth to sturdy calves that put on weight fairly rapidly before they are weaned.

Charolais cattle bulls were first imported into Britain in 1961 from France in the hope that crosses with Friesian cows would produce quick-fattening calves. In Europe and the United States the Charolais had proved itself as a cattle breed with a fast growth rate giving exellent lean meat. The crosses with Friesian cows were most fruitful. The cross-breds grew 10.6% faster than the Hereford-Friesian crosses and were more efficient at converting their vegetable food into meat.

Ancient and modern cattle

The development of British cattle breeds started in the 18th century, mainly because the population increased dramatically and demands were made on farmers for more food. New fodder crops meant cattle could be fed through the winter and good breeds bred. Some breeds have been lost but many old breeds have been preserved and adequate stocks still exist with irreplaceable genetic qualities.

In the last decade British beef farmers have imported several foreign cattle breeds that are referred to as 'exotics'. The dual-purpose white-faced Simmental originated in Switerland, but since 1970 there have been importations from there and Austria. Limousins, native to upland areas of west central France, arrived in 1971. The massive Chianina arrived in 1973.

Welsh Black Dual-purpose breed in the past but now regarded as a beef breed. Mature bull 550kg (1212lb)

Hereford Dominant breed in Britain, accounting for 60% of all beef bulls produced. Mature bull 526kg (1160lb)

Beef Shorthorn One of the breeds used to develop the Luing. Mature bull 472kg (1040lb)

Luing Named after the Scottish island where it was developed this century. Mature bull 520kg (1146lb)

Galloway Developed in the rainy, windswept hill areas of southwest Scotland. Mature bull 415kg (915lb)

Above: **Crown vetch** (*Coronilla varia*) is one of the many members of the pea family found on grassland. Introduced to the British Isles from the Mediterranean, it can grow to a height of 60cm (2ft), flowering June-August.

GRASSLAND FLOWERS: GREAT AND SMALL

Although the rolling downlands provide our richest grassland flora, wild flowers can be found in almost any grassy situation. Hedgerows, rough pasture, village greens, golf courses and the grassy borders of disused railway lines all provide a home for an interesting variety of species.

Grassland is a very diverse habitat. The variety of conditions under which it is formed, and subsequently managed, produces greatly differing selections of wild flowers. Generally, grassland on chalk or limestone is much richer in species than the acid grassland of our northern uplands. The length of the grass also has a direct influence on the type of the flowers to be found there.

Long grass If the grass is fairly long, there are likely to be fewer species present, because the smaller flowers are choked. In long grass, tall pioneer species such as the thistles grow best of all.

Thistles belong to the Compositae family, along with daisies, knapweeds and dandelions. On chalk or limestone soils, you may well come across the handsome musk thistle. It is the fragrant musk-like scent of its flowers that gives this species its name. The musk thistle is readily identified by its large pinkish-purple flower heads which, unlike other thistles, hang gracefully down under their considerable weight – hence the alternative name of drooping thistle.

Knapweeds, close relatives of the thistles, grow in hedgerows and in the long grass of rough pasture. They differ from thistles in that the edges of the leafy bracts surrounding each flower head are thin and papery, instead of drawn-out into sharp prickles. The greater knapweed has green bracts, while those of the lesser knapweed are blackish-brown. Both species are popularly known as 'hardheads'.

Clovers and vetch Where the grass is a little shorter, you will find the members of the pea family (Leguminosae). The peas, beans, lupins and laburnums of our gardens also belong to this family.

Red clover is a familiar grassland flower, and the rarer zig-zag clover, which is often confused with it, favours the same habitat. Zig-zag clover owes its name to the zig-zag growth of its stems, and it can be recognised by the noticeably flattened head of flowers, which is a much darker red than that of the red clover. More common in the north of Britain, it can be found if you look closely in dry pastures and bushy places.

Also closely related to each other are the

Thistle structure
The head of a thistle is not a single flower, but a capitulum – many tiny individual florets, packed tightly on to the flattened head or receptacle of the stem. Each floret is a long tube made up of five narrow petals, containing five male pollen-bearing stamens. The heads of the stamens fuse together to form a hollow column around the single female style. The stigma protrudes from the tube of petals (corolla), to catch the pollen carried by visiting insects. After pollination, a one-seeded fruit is formed at the base of the style, and when mature, a feathery outgrowth or pappus provides each tiny fruit with its own parachute.

white or Dutch clover and the less common alsike clover. The latter, introduced as a fodder crop, is more usually found as a weed growing in cultivated land along roadsides. It differs from the native white clover in that it never creeps along the ground; its tall branched stems may reach a height of 60cm (2ft). From a distance, it can be recognised by the strong, pinkish tinge to the otherwise white flowers that actually grow more noticeable as they fade.

A sunny, grassy bank is the preferred home of the wild liquorice, or milk vetch. Although this is not the species from which commercial liquorice is obtained, a sweet juice was formerly extracted from its roots and used to flavour drinks. It is a stout, almost woody, straggling perennial, and can be distinguished easily from all the other vetches and peas by the oval heads of large, short-stalked, greenish-cream flowers and equally large pinnate leaves. Mainly southern in distribution and absent from Ireland, this local plant favours limestone soils.

Small flowers of the turf Regular mowing on golf courses, and close grazing by rabbits (on disused railway lines for example) results in a short, dense turf which usually produces a wide variety of small flowers, some of which are characteristic downland species.

One of these, fairy flax, is well-named. It has slender, thread-like stems, no more than a few inches high, and the plant would never be seen if it were not for the loosely branched heads of small white flowers. Equally difficult to see, but often discovered unintentionally by picknickers who sit on it, is the dwarf or stemless thistle. Unlike other thistles, this species rarely has a stem at all, its smooth flower heads arising directly from a basal rosette of prickly leaves. It grows in dry, lime-rich soils and has a deep tap-root which helps the plant to survive long and severe periods of drought.

Eyebright is another typical plant of the short turf. Infusions of the plant were once used to treat eye infections–hence its name. There are about 25 species of eyebright in the British Isles, but the one you are most likely to see is the widely distributed common eyebright. The plant is sometimes parasitic on the roots of grasses, although it does produce its own food by the process of photosynthesis.

Wasteland plants A hard, compacted surface, such as that found in many wasteland areas, tends to create a thinly vegetated grassland habitat which has its own characteristic flora. Weld, also known as dyer's rocket, is a plant found here. Similar in appearance to the wild mignonette (illustrated above right), it is a tall, stiff plant with a long narrow spike of greenish flowers. The whole plant can be boiled to yield a beautiful yellow dye, and before the introduction of artificial dyes, was much cultivated for this purpose.

Above: **Wild mignonette** (*Reseda lutea*) flowers June-Sept on wasteland. Unlike the garden variety, the flowers are scentless.

Musk thistle (*Carduus nutans*) flowers June-Aug. on chalky soil, wasteland. Ht 90cm (3ft).

Lesser knapweed (*Centaurea nigra*) flowers June-Sept on grassland, waysides. Ht 40cm (16in).

Greater knapweed (*Centaurea scabiosa*) flowers June-Aug. Ht 60cm (2ft)

Stemless thistle (*Cirsium acaulon*) flowers July-Aug. Ht 20cm (8in).

NATURAL LIFE IN OUR TOWN PARKS

Although St James's Park (below) was first laid out in the 17th century, most town parks date back to Victorian times. Parks are essential places of rest in towns, and can at the same time become important habitats for wildlife.

Town parks are usually the first places that come to mind at the mention of urban wildlife. To generalise can be misleading, for town parks range from fauna-rich examples such as Sutton Park near Birmingham and Richmond Park on the edge of London to the type which is little more than a football pitch. Lying between these extremes of biological richness and poverty, the majority of our town parks belong to the tradition of Victorian pleasure gardens.

In the last century, philanthropists and local authorities bought pieces of urban land and laid them out as public gardens. Here the urban working class could find relief from dirt, drudgery and poverty in the presence of

green plants, birds and relatively fresh air–without having to journey out to the open countryside.

These parks mirrored the private gardens and grounds of the Victorian rich. Because they were thought of as gardens they were planted with ornamental trees and shrubs; they had flower borders in which annual bedding plants were the order of the day; they contained ornamental pools, statues and buildings, and the grass was close-mown.

Changes in their management have taken place since the Second World War, brought about partly by the pressure of rising costs, bringing the need to make economies and use less labour. An interesting result of this is that nowadays some parks–Hyde Park and Holland Park in London for example–have areas where the usual park-keeping work is kept to a minimum and natural life is allowed to continue relatively undisturbed.

What may be found in a town park by way of wild plants and animals depends on many factors. Besides the particular style of management under which a park is run, these include the size and structure of the park, and its position in the city; and whether it lies near or far from other places in which there is plenty of wildlife. If you know the pieces of the jig-saw you can build up a picture for your own local park.

Life on the rocks The most basic of all habitats is bare rock. This supports a range of lichens and they in turn provide a home for tiny insects and mites. The more polluted the air and the more acid the rock, the fewer lichens will grow. Since the 'rock' in town parks ranges from concrete kerbs to marble statues, and from brick buildings to paving slabs, there is usually a great variety of sites for the growth of lichens. The further away a park is from sources of air pollution–and this generally means the further it is from the city centre–the greater the variety of lichens you can find.

Soil From rock is derived bare soil, which is often heavily trampled and compressed, with hardly any decaying plant remains. Here little life is found, but quite a number of solitary bees and wasps burrow in the hard packed ground to make their nest chambers. Whether or not you have these fascinating insects in your park depends on the food available to them in the park or nearby.

Bare soil is also found in plenty in the flowerbeds themselves, in between the clumps of cultivated flowers or shrubs. Here the rich earth is untrampled and forms a perfect habitat for weeds. No matter how carefully the park may be tended these colonizing plants inevitably find a foothold. They are by nature pioneer plants, whose specialized ability is to spread seed fast and take advantage of any place where the earth has been opened or disturbed. A characteristic of pioneer plants is that they produce large amounts of seed, which makes them a boon to all seed-eating birds.

Above: A grey squirrel demonstrates its uninhibited style of scavenging. Such plentiful supplies keep the numbers of grey squirrels higher than in natural woodland.

Mown grass, or lawns, form another major ingredient in the park's mixture of habitats. The range of plants which grow in a lawn varies according to the past management of the lawn and the kind of treatment it has received. If it has been regularly mown, fertilised and subjected to weedkillers then it will be poor in terms of the variety of plants and small animals which can live there. It will therefore be unattractive to birds, amphibians, reptiles and mammals. If, at the other extreme, it is cut infrequently, like a hay meadow or a pasture, it can contain a wealth of different plants with butterflies, moths, gaudy beetles, jewel-like spiders, voles, toads and birds in plenty.

Shrubberies If the park is to attract birds, shrubberies are a vital part of the picture. Without shrubs there will be no warblers, such as black-caps, to enrich the park with their song. If ornamental foreign shrubs are mixed with native ones such as hawthorn, pussy willow, holly and ivy then there are riches indeed for wildlife. Native species are more interesting because they support more insects: introduced shrubs are unfamiliar to our native stock of insects, and an insect can live on an alien shrub only if it manages to adapt to it–which some are doing successfully.

Woodland Trees and woodland add another dimension. As with the shrubs, the native

Nature relieves stress

Over a hundred years ago it was realised that urban man needed open green space. Now the need is felt for a closer link with nature and for parks to be given a role more akin to that of nature reserves. We also know that open spaces with trees, water and grass play an important part in reducing the pollution of the air. They help to absorb dust and smoke, and fumes from cars, so letting light and health back into the city centre. They deaden noise and draw a green curtain in front of sights best left unseen.

Left: A small tortoiseshell butterfly on a shining honeysuckle shrub (*Lonicera nitida*). The foodplant of its caterpillar is the stinging nettle, no more than a nuisance to gardeners and public alike. If the odd patch of nettles survives, the park will be alive with butterflies and a great many other colourful insects in summer.

oaks and limes support more wildlife than foreign trees such as sycamore, tulip tree or acacia. However, some exotics add variety and interest; and if you want to see tree-creepers, there is no better place to look than on a Wellingtonia tree with its soft bark so loved by these small birds.

In park woodlands there is a direct conflict of interest between the needs of wildlife and the demand for public safety. From the point of view of the wildlife, dead and dying trees are among the most important parts of a woodland ecosystem. In a park they are almost always cut down and taken away, but sometimes even in town parks small amounts of wood are left lying on the ground. This gives a home for the large and beautifully marked longhorn beetles, whose larvae are a prized delicacy for the great spotted woodpecker and the golden-furred noctule bat. A small supply of rotting wood, even a dead treestump cut almost level with the ground, may be adequate for toadstools, ferns and mosses to grow, or for beetles to burrow in.

Lakes and pools The final piece of the jigsaw is open water. At one end of the scale there are large lakes, rivers and streams, and at the other small pools, drinking fountains and temporary puddles. Water is vital to all forms of life. It is irresistibly attractive not only to those species which obviously depend on it–fish, ducks, frogs, newts and various insects such as dragonflies–but also to dry-land animals and birds which come to drink. For any piece of land to be really attractive to a wide variety of animals and plants, open water and a marshy fringe is an absolute necessity.

Most parks have some permanent water and many birds make their home on it. Coots and moorhens, and the ubiquitous mallard, are usually on town park lakes and ponds all year round, and Brent and barnacle geese and Bewick's swans may appear in winter. You can also often see tufted duck and pochard, and sometimes the introduced mandarin duck, the males instantly recognisable by their exotic colouring and upstanding orange 'sails' on the wings. All these birds eat bread thrown to them by people in the park. Where concrete has not been too liberally applied, a gentle bank allows ducklings to climb or hedgehogs to escape if they fall in while trying to get a drink. Frogs and newts are able to come and go on the gentle gradient, and the marshy fringe is beneficial to the insect community too.

Take away any of these pieces and the picture is incomplete: the park loses something of great value to wildlife. So far as wildlife in the British Isles is concerned, the most important components are open water and marsh, woodland with a good shrub layer and meadow grassland. The more of these a town park possesses, the closer nature is to the town centre.

Below: The pochard has a resident British population which is enlarged in winter by the arrival of migrants from the north. These colourful birds can be encouraged by sympathetic park management–not least by providing a marshy waterside.

AN OCTET OF ORCHIDS

Late-season orchids, found mainly on the warm, chalky soils in the south and east of the British Isles, are just as fascinating and rare as their more flamboyant early-summer relatives.

The orchid family is made up of a wide variety of species, from the magnificently coloured and rather exotic-looking lady's slipper and military orchids, to the more subtly coloured varieties hidden deep in the woods or resting unnoticed among the grass or moss. Late-season orchids can be easily missed because of their chosen habitats, but they are well worth looking out for.

Chalk and limestone orchids Autumn lady's tresses is a locally common plant of dry pasture land, with an especial liking for chalk or limestone. Although the warm chalkland, with its short turf, is ideal for such a small orchid, it can be found on almost any well-drained soil. A rosette of blue-green leaves appears in June, dying away in August before the appearance of the flower spike, which only reaches a height of about 15cm (6in). As with many other orchids, the appearance of this plant varies widely from year to year, possibly reflecting differences in the activity of the mycorrhizal fungus which is essential for good root growth (see page 663).

Frog orchid is another species that favours the short turf of chalk or limestone soil and there is a mountain variety that can also be found on grassy rock ledges at over 1000m (3300ft) in Scotland. The species has green, rather inconspicuous flowers, which, from the side view, bear a slight resemblance to a leaping frog. The frog orchid is easily missed because of its coloration, but the mountain variety has red or purple flowers which help to distinguish it from its surroundings.

Woodland orchids Several orchids can be found growing in beech woodland, which also favours chalk and limestone soils. By far the most unusual and interesting of these is the ghost orchid. Growing in the thickest part of the wood where the light rarely penetrates, this species has no green colouring (chlorophyll) and feeds saprophytically off dead vegetable matter. The fairly large, scented flowers are almost transparent and tinged with yellow, red and violet. Ghost orchid is very rare, with only two sites known in the British Isles; even in these places its appearance is rather irregular. Up to 1955, it had been recorded from both sites on only nine occasions in the previous 100 years. Since then, for no apparent reason, it has appeared more or less annually.

Above: The ghost orchid (*Epipogium aphyllum*) takes its name from its pale, ghostly appearance. Growing deep in the heart of the wood, it is a very rare and unusual plant, and one of Britain's protected species.

Helleborines Mid to late summer is the peak time for most helleborines, some of which continue to flower through the autumn. The flowers of these species have a distinctive structure which helps us to recognise them. The lip of the flower is divided into two readily identifiable parts – the cup-shaped top part, known as the hypochile, and the flat bottom part, known as the epichile.

Four species of helleborine are found in the beechwoods of southern England: common or broad-leaved helleborine, violet helleborine,

narrow-lipped helleborine and green-flowered helleborine. Compared with the other species, the broad-leaved helleborine is a fairly common plant throughout most of Britain, except northern Scotland. It has broad leaves, arranged alternately up the stem, and a long spike of flowers (up to 100 in well-grown specimens). The flower colour varies from almost white to deep pink, while there may be a very marked colour difference between the main flower and the epichile.

Pollination is helped by the secretion of a quick-drying cement-like substance, which is contained in a thin sac between the stamens. When a nectar-seeking insect alights on the flower, its movements burst this sac, liberating the 'cement'. This, together with a number of pollinia (pollen masses made up of a large number of pollen grains), adheres to the insect. The insect carries this to the next flower, where some pollinia will be left to pollinate the stigma of the flower.

The three other species of hellborine are rarer and less widespread. Violet helleborine is a lover of shady places, again usually in beechwoods. It is similar in general appearance to broad-leaved helleborine, and can be even larger and more robust. You can recognise it by the pale, whitish-green flowers, which have a pink tinge over the white epichile. Other distinguishing features are the leaves, which are grey-green and purple underneath, and the cluster of flowering stems, rather than just one or two, which appears in the mature plant.

Narrow-lipped helleborine has oval green or yellow-green leaves, and flowers that are often larger than those of the broad-leaved helleborine. It can be recognised by the long, narrow pointed epichile which gives the species its common name. A characteristic southern plant, it has never been recorded further north than mid-Wales. The beech-woods of the Chilterns seem to be its favourite habitat, where it often grows in such deep shade that one wonders how it finds enough light to survive.

Green-flowered helleborine is found mainly in Hampshire and Wiltshire. It has apple-green flowers, with long bracts on the flower spike. These flowers are often cleistogamous, which means they are self-pollinated – before the flowers actually open.

Rare wetland species The late summer flowering bog orchid, does not like the dry, chalky soil of beech woodland, but prefers the saturation of a sphagnum bog. It is a very small species with an average height of 5cm (2in), although it can sometimes reach 12cm (5in). The flowers are almost invisible, particularly on the cushions of sphagnum moss where they are found, and they are probably pollinated by flies and midges. It is hardly surprising that this is one of the most consistently unseen, and probably under-recorded, orchids.

Right: Autumn lady's tresses (*Spiranthes spiralis*) is so named because of its resemblance to a twist of flowers used to decorate a braid of hair. It is unusual among orchids in that the bell-shaped flowers, which are scented in the evening, are arranged spirally up the stem. It flowers from September to October.

Below: The bog orchid (*Hammarbya paludosa*) merges well with its background, even in the flowering period of July to September. Its few yellow-green fleshy leaves develop small buds on their edges which can form new plants.

Frog orchid
(*Coeloglossum viride*)
flowers June-August on pastures and grassy hillsides. Ht 20cm (8in).

Green-flowered helleborine
(*Epipactis phyllanthes*)
flowers July-August, mainly in woodland in S England. Ht 30cm (1ft).

Violet helleborine
(*Epipactis purpurata*)
flowers August to September. Found in beech woodland.
Ht 45cm (18in).

Narrow-lipped helleborine
(*Epipactis leptochila*)
flowers June-August in shady woodland and dunes. Ht 45cm (18in).

Broad-leaved helleborine
(*Epipactis helleborine*)
flowers July-October in woodland, and shady places.
Ht 50cm (20in).

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What is Mycorrhiza?

Many plants, such as heathers and pines, have fungi closely attached to their roots, often with the fungal body (the mycelium) forming a dense coat around the roots. Such a relationship is a delicate balance between fungus and plant. If the plant is weak, the fungus invades and destroys tissues; if the fungus weakens, the plant produces non-infected roots. When the roots are covered in fungal mycelium, water and mineral salts pass more easily from the soil to the plant. Such salt movement is essential for fungus growth, and the plant benefits from anything in excess of the fungus's requirements. Without the fungus, the absorption of mineral salts and water is significantly slower, which means that root development and plant growth slow down as well, and the plant weakens. However, as it weakens, it becomes susceptible to fungus attack and the cycle begins again.

Orchids have a mycorrhizal system that is actually inside the root or rhizome, but the process works in the same way. The orchid benefits because it can obtain salts and water more easily through the fungus. The fungus benefits by obtaining nutrients and mineral salts from the broken-down plant roots.

Broad-leaved helleborine

Narrow-lipped helleborine

Violet helleborine

Green-flowered helleborine

Frog orchid

CUTTLEFISH

Cuttlefish–jet propelled predators perfectly adapted to their environment–skim over the sandy coastal shallows.

Five species of cuttlefish have been recorded in British waters, the common cuttlefish and the little cuttle being most frequently seen. An adult common cuttlefish reaches a length of 30cm (12in). It is widely distributed around the coast of the British Isles, mainly in shallow water.

Cuttlefish are invertebrates, relatives of squids and octopuses, which are together known as cephalopods. This term refers to the head (Greek: *Kephalus*) and foot (Greek: *Pous*), which are virtually fused together, distinguishing them from the related bivalve molluscs in which these features are widely separated.

A predator of small fish and swimming crustaceans, the cuttlefish is a highly specialised form of mollusc, streamlined and ideally equipped both for rapid movement through the water and for lying concealed on the seabed. The animal is divided into three sections: the tentacles, which have evolved from the flat sole-like foot of its primitive ancestor (still present in many less advanced forms such as limpets); the head with its large brain and conspicuous eyes; and the body region, which houses the gut, respiratory, excretory and reproductive systems.

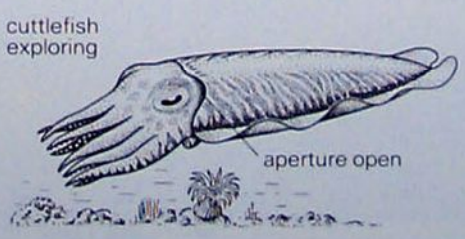
Tenacious tentacles There are eight short, suckered tentacles which the cuttlefish holds out in front of it as it swims. These are sometimes grouped together to form a shield in front of the head. The tentacles are equipped with touch receptors which pass information to the nervous system about the objects with which they come into contact. The suckers are used for holding on to prey, which is captured with two additional, much longer, suckered tentacles. The cuttlefish can project these out from among the shorter tentacles with great accuracy to seize the unsuspecting prey.

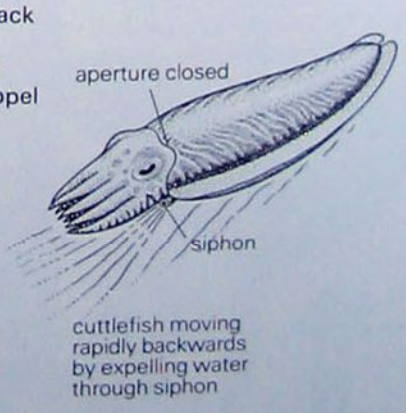
The head The large and highly developed brain is housed in a cartilaginous brain case. The size of the brain means that cuttlefish are relatively intelligent and capable of learning by experience. On either side of the head there are two large eyes, mounted in eye sockets, which can see ahead and behind

Above: The courtship ritual of a pair of common cuttlefish (*Sepia officinalis*). This involves the male changing colour, and precedes reproduction, where the male uses a modified tentacle to transfer a capsule of sperm from his own mantle cavity to that of his mate. The eggs are fertilised there, then released in groups and attached to weeds, where they develop into juveniles, which swim actively and feed on plankton.

Jet-propelled movement

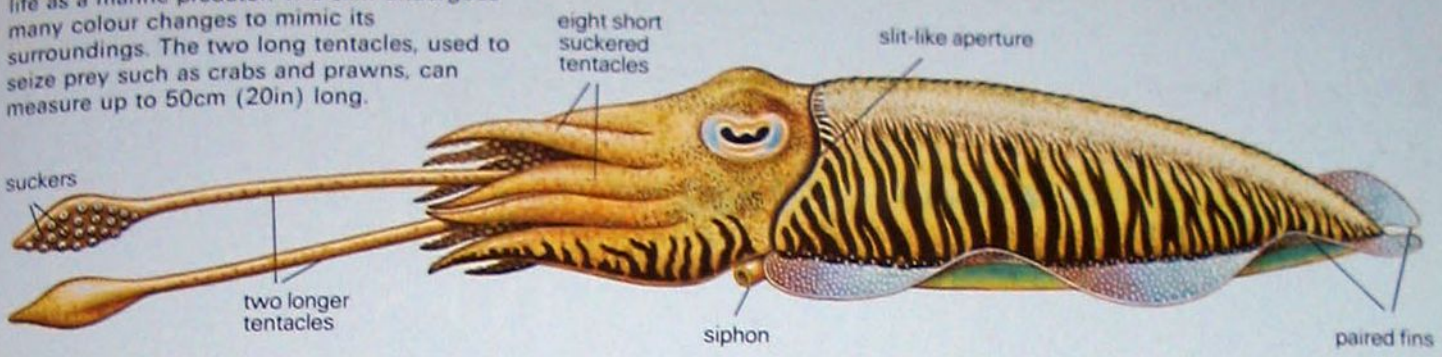
A cuttlefish swims slowly by a rippling movement of the paired fins which run back from the head to the tip of the body. If disturbed, it can close the aperture and force water through the siphon, to jet-propel itself rapidly backwards to safety.





Cuttlefish anatomy

The common cuttlefish is perfectly adapted to life as a marine predator. The skin undergoes many colour changes to mimic its surroundings. The two long tentacles, used to seize prey such as crabs and prawns, can measure up to 50cm (20in) long.



very efficiently. They are used to spot prey and predators, as well as to gauge the background colour of the sea-bed. This is important in the cuttlefish's complex protective camouflage system, which is controlled by the nervous system. Cuttlefish skin carries many hundreds of adjustable pigment cells, called chromatophores, that can rapidly expand or contract the pigment they contain, thus making the skin darker or lighter. These dramatic pigment changes can take place in seconds and allow the cuttlefish to blend in well with its background, hiding it from potential predators.

The head has a pair of horny jaws, used for breaking up the prey. These resemble the beak of a parrot in shape and size, and are similar to the jaws of squids and octopuses. Lying inside them is another structure typical of molluscs. This is the radula, a long, toothed tongue which is used for rasping at the prey. Cuttlefish also have salivary glands to assist in swallowing the food.

The body This contains the large and fairly bulky internal organs, surrounded by the mantle which, as in other molluscs, secretes the shell. In the case of cuttlefish, the shell is internal. It is the familiar white shield-shaped object commonly used as a source of calcium carbonate for cage birds. The cuttlefish shell, or 'bone' as it is incorrectly called, is porous, and comprises thousands of microscopically small cells. By filling these with gas, the cuttlefish can make itself more buoyant, and by replacing the gas with liquid, it can decrease its buoyancy. This is a great advantage for it means that the animal can adjust its depth in the water without having to swim actively. In this way, it is similar to fish, which use a gas bladder to control their buoyancy.

On the underside of the body lies the mantle cavity; this houses the two large gills, the heart, the openings of the excretory system and sex organs, and the ink sac. The cavity opens to the exterior by a large slit-like aperture which runs round from one side to the other below the animal. Situated inside this large opening is the funnel, the outer end of which looks like a tube or siphon. The gills are ventilated by movements of the muscular lower wall of the mantle, which draws water in through the large opening, passes it over the gills and then expels it through the funnel and siphon. The exhalant stream carries away any waste material at the same time.

Jet-propulsion The exhalant water stream, while essential for respiration and dispersal of waste substances, is also used in jet swimming. When the cuttlefish is alarmed, it can make a rapid escape by suddenly contracting the mantle and forcibly expelling the water contained in the mantle cavity via the funnel and siphon. This has the effect of rapidly jet-propelling the animal backwards. It is also sometimes associated with the discharge of ink from the ink sac, which distracts the oncoming predator and makes a 'smoke-screen' behind which the cuttlefish can retire.

Two factors help the effectiveness of this escape mechanism. First, the cuttlefish has an advanced nervous system, with a number of extremely large nerve cells, that rapidly transmit messages to the brain, so alerting it to the presence of danger. Secondly, this escape system would not work without a means of closing off the mantle cavity to prevent water from 'backfiring'. This is done by muscles with special stud-like cartilaginous outgrowths on the outer mantle wall which clip, like garment press-studs, into sockets on the funnel surface, closing the apertures.

Below: The little cuttle (*Sepiola atlantica*), is a miniature cuttlefish, growing to about 5cm (2in) in length. It is rather more rounded than the common cuttlefish, and has flap-like fins and shorter tentacles. The colour varies from almost black to very pale cream, and it is sometimes found burrowing into the sand.

NEW FOREST PONIES: STURDY NATIVES

Over 3000 New Forest ponies roam the Hampshire forest–once the hunting ground of kings. Their numbers vary from one year to the next, depending on the harshness of the winter, the number of foals born and the quality of food available.

The 'forest' which is the home of the sturdy native New Forest pony, is in fact, mostly bare of trees, offering the poorest grazing to the ponies. Much of it is heather moorland dominated by patches of gorse. These wide expanses are intersected by valleys, at the bottom of which are streams or treacherous bogs.

The origin of the New Forest ponies is simply not known. Wild horses living in the New Forest are mentioned in old manuscripts that date from King Canute's reign (about 995-1035AD). Probably they have been there continuously ever since.

Agisters and Verderers During the 12th century New Forest ponies came under the ownership of local residents who turned them out to graze the Forest under 'common rights'. Today the local residents still own the ponies and are called 'commoners'. While on the 'common', the well-being of the ponies is maintained by four wardens called 'Agisters' who ride the Forest daily, observing and reporting back to their employers, the 'Court of Verderers'. The Verderers, made up of representatives of the commoners, the Crown (the land-owners) and certain other bodies, undertook the running of the Forest and the enforcement of the complex Forest laws. However, since 1924 Forest management has been the responsibility of the Forestry Commission, with the Verderers advising and looking after the interests of the commoners. This ancient and unusual form of management is financed by means of a 'marking fee' which is charged for each animal using the common land, and such animals are marked by branding and tail clipping.

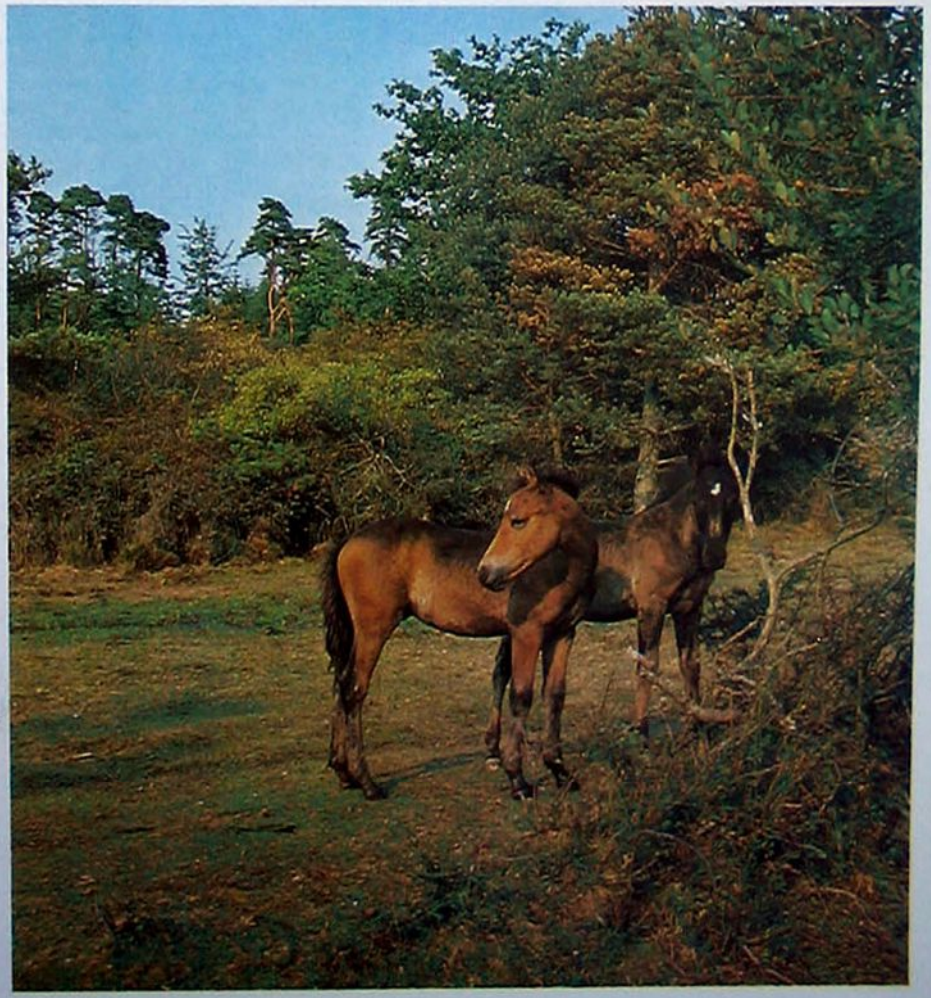
Cross-breeding It is probable that from the 13th century attempts have been made to improve the Forest ponies by removing weak and malformed animals. Over the last 250 years introduction of other breeds (including Arabs and Thoroughbreds as well as Highland, Welsh and Exmoor stallions) have been made in an attempt to improve the stock. However, the way it was done was somewhat haphazard and the results not always successful. Undoubtedly some have had a harmful effect, especially when Arab stallions were used. Almost without exception, the resulting offspring lost much hardiness and their shape altered. Queen Victoria's Arab stallion, Zorab, was mated with over 100 mares between 1852 and 1856, but he did not effect the breed as a whole. However, some New Forest ponies do have a marked Arab look, so other Arab stallions must have mixed with the mares at some time.

Despite this history of cross-breeding, the original New Forest type still thrives. The classic Forest pony normally stands up to 14·2 hands high at the shoulder (142cm or 4ft 8in). It can be any colour except piebald or skewbald, with bay being the most common. A well bred New Forest pony

Above: Feeding time. Foals begin to nibble in August.

Right: An attractive foal with a white head blaze. Any body colour is acceptable for the breed except piebald and skewbald. Most foals are born in May and June.

Below: New Forest ponies 'lawn-grazing'. These areas, that look as if a lawn mower is used to cut them every week, are the result of the ponies cropping the grass daily.



should show the common pony characteristics of a stocky build, small head in relation to body size, and small ears. There is a tendency, however, towards a more lightly built animal in the relatively uncontrolled breeding conditions of the open Forest. Despite its defects, however, the breed makes a good, versatile riding pony due mainly to its even temperament.

Breeding cycle In spring, during the months of May and June, the New Forest foals are born, after a gestation period of 11 months. The weather is usually fine and food plentiful. Over the first few weeks of life the mother is very protective toward her foal and it is best not to approach too closely. The mare spends many hours feeding since she must not only provide milk for the foal, which grows rapidly, but also build up her own reserves of fat after the rigours of the preceding winter. Most of the daylight hours are spent grazing the grassland areas of the Forest to such an extent that the areas look like lawns. In the wetter areas of heathland or bog the ponies eat the tall purple moor grass. By night the ponies continue to feed in woodland or gorse thicket.

The mating season starts with the appearance of the first foals. Many stallions are released on to the Forest at this time. These animals have spent most of the winter in a field or a stable under their owner's watchful eye. The stallions are excellent New Forest ponies that have been selectively bred by their stud owners over the last 40 years so that the ponies do not lose the characteristics of the breed.

Each stallion disrupts the normally quiet wanderings of the mares, herding them together in groups of as many as 20 or more and fighting off rival males to secure his own breeding success. Mares that have given birth that year are usually in too poor a condition to conceive. They will produce the next year or even the one after that.

Mating continues into August, but most mares are more concerned with feeding, often for up to 22 hours a day. By now the young foals have begun to nibble and chew.

Above: A drinking pool gathering. Herds often consist of several generations of the same family. Although they are at liberty to wander, they usually stay in one spot.

Below: Autumn round-up. This annual occurrence, known as a 'drift', is one of the most splendid and exciting features of the New Forest year. Ponies are herded into stout wooden pounds by colt-hunters – as the riders are known. Some are sold, others are branded.

Going to shade As the summer progresses an enemy emerges to upset the peaceful existence of the ponies–the biting fly. The ponies are clearly troubled by blood-sucking insects and they huddle together in groups of up to 100 animals. This is known as 'shading' or 'going to shade'. It has no connection with avoiding the sun. The ponies move to exposed sites which apparently attract more breeze than others and are not so attractive to the swarms of vicious biting insects.

These immovable groups of ponies are often encountered by car drivers in the forest, since the bare road surfaces, with their lack of vegetation cover for insects, seem to provide an ideal shading site.

Round-up time Over the autumn months, the commoners hold a series of rounds-up (drifts) over the whole of the Forest. These drifts are a long-standing custom and are a social as well as a practical event. The rounding up is done on horseback, by far the most efficient means of transport on the open Forest, and provide exciting riding for all involved. One area is covered each day and as many ponies as can be found are driven to permanent pounds or enclosures. The animals are inspected and those judged to be unfit to face the rigours of winter are removed to the shelter of a field or a stable.

Many foals are taken to be sold at the autumn pony sales. Those ponies which are to remain on the Forest are treated against parasite infection and any minor ailments and have their tails clipped in a characteristic way to show that they have been caught in the round-up and that the owner has duly paid his marking fee. They are also branded, using a hot-iron brand, so that the owner of each pony may be identified.

Survival in winter Ponies that are not removed during the autumn drifts and sales are left on the Forest to face the oncoming winter. Food supplies begin to dwindle.

When weather conditions deteriorate further, the ponies seek shelter in the woodlands and gorse thickets. The exposed grasslands now offer little food and are seldom visited. The animals take a wider diet, which includes holly, bramble and gorse. Ponies are well able to feed on such prickly growth, but their willingness to do so varies from one individual to another. It is likely that those animals most directly descended from the original wild breed, with their small stature and native cunning, are better able to feed and keep healthy in difficult conditions than those more influenced by cross-breeding.

As winter continues and fat reserves become depleted, both Agisters and commoners watch the animals carefully to make sure they do not starve or possibly even die as a result of prolonged cold and rain.

Some ponies are removed to the shelter of their owner's field or stable, while others are given hay.

NEW FOREST PONY

Size Two sizes recognized
Type A: Ponies up to 13.2 hands (132cm or 4ft 5in). Ideal as children's hunting pony.
Type B: 13.2 hands to 14.2 hands (132cm or 4ft 5in to 142cm or 4ft 9in). Stallions usually larger and more heavily built.
Colour Can be any colour except piebald or skewbald.
Breeding season Single foal born May to June, a few in July and August.
Gestation 336 to 340 days.
Lifespan Up to 18 or 20 years.
Food Mainly grass, rushes and sedges, but overwinter diet includes gorse, holly, bramble and some heather.
Predators None, but troubled by parasitic flies and worms.
Distribution Free-ranging only in the New Forest, but riding ponies found worldwide.

Left: Equipped with a thick coat of hair to withstand the cold, a New Forest pony grazes on a sunny winter day. As the grazing areas are so poor, gorse and holly are eaten.

DADDY LONG-LEGS

A cranefly, with its hunched back and enormously long legs, looks like a caricature of an insect. Surprisingly, our 300 species, including the pair above, have rarely been studied and little is known of them.

Craneflies are members of the insect order Diptera and are true flies, with one pair of functional wings. As in all Diptera, the hindwings are much reduced in size to form small knobbed projections, called halteres, which are sense organs that act like gyroscopes and enable the fly to keep its balance. Craneflies belong to a distinct family, the Tipulidae, and have long, thin, soft bodies, narrow wings and long spindly legs (which have earned them the name 'daddy long-legs'). They look like oversized mosquitoes but cannot bite or sting and are completely harmless. Pick one up and almost certainly one or more legs will break off. This is probably a means of escaping from predators such as birds.

There are about 300 species in the British Isles, but most are small and hard to find, and even harder to identify. They are common in grassland and woodland.

Hunchback adult Under the microscope, magnified ten times, an adult cranefly resembles a hunchback with an armour-plated box of a thorax, from which originate three pairs of legs, the wings and the halteres. The head projects forward to form a sad-looking face with two large, black, compound eyes. Two small antennae rise from the head.

The abdomen is cylindrical and soft. It is the long spindly legs that are most striking: they are completely covered with black bristles, invisible to the naked eye, and there are what appear to be numerous knee joints. At some of the joints there are small but sturdy black spines, and there is a pair of black claws at the tip of each foot which, together with an adhesive pad between the claws, enable the insect to cling to vegetation.

The description above fits our commonest species, *Tipula paludosa*. This one, and others, do not have English common names. *T. paludosa* is not only the commonest but also one of the largest and most conspicuous craneflies in Britain. It is a drab-looking insect, about 2·5cm (1in) long, and can frequently be disturbed in grassy fields; it is also commonly attracted to lights at night. It first appears in June but is mainly a late

Winter gnats

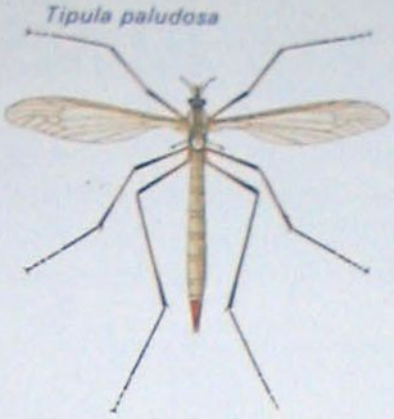
Sometimes called winter craneflies, winter gnats are delicate insects resembling true craneflies but placed in a separate family, the Trichoceridae. They are commonly seen in dancing swarms on mild days in winter. They are about at other times of the year but are easily overlooked.

Winter gnats differ from craneflies in details of wing venation and in the presence of simple eyes (called ocelli) on the head (craneflies do not have these). The larvae have a proper head and feed on decaying leaves and other vegetation.

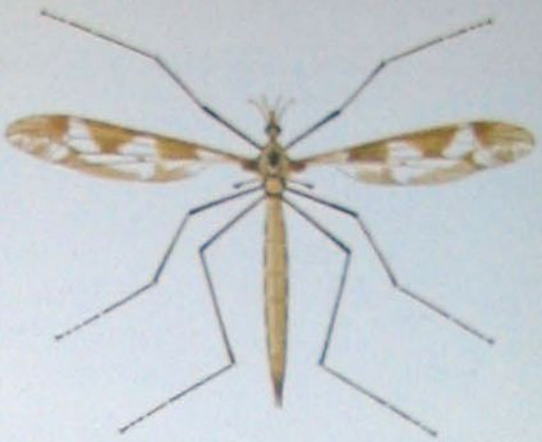
Only ten species of winter gnat occur in Britain. All tend to frequent cool, shady places and you'll find them in gardens, perhaps in the shelter of a hedge or tree, bouncing up and down in the air in the weak winter sunshine. Disturb them and they quickly return to the same place.

Three common craneflies

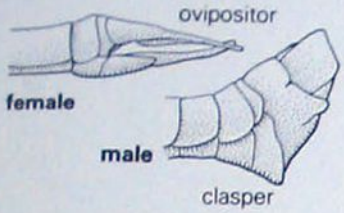
Tipula irrorata



Tipula paludosa



Tipula maxima



Above: You can tell the difference between male and female craneflies by the shape of the abdomen tip: the female (left) has a long ovipositor, the male (right) knobby claspers.
Below: Cranefly larva, often known as a 'leatherjacket'.

Below: Cranefly of the genus *Nephrotoma*. The yellow and black body gives it a superficial resemblance to a wasp and may help to protect it from predators.

summer and autumn species, with a peak in August and September.

The female has a rather long ovipositor which she inserts into the soil to lay somewhat elongated, 1mm ($\frac{1}{25}$in) long blackish eggs which look a little like dried seeds. Two or three hundred eggs or more are laid by each female.

Leatherjacket larvae In about two weeks cranefly larvae hatch and begin to feed voraciously on roots, especially those of cereals and grasses. Their tough outer skin has earned them the name 'leatherjacket'. Their heads are partially withdrawn into their bodies and their jaws bite transversely, unlike those of fly maggots which work vertically. They can be very destructive in lawns and pastures.

Leatherjackets survive best in cool, wet summers in damp pastures, many dying of desiccation if the weather is too dry. The larvae grow slowly, moulting their skins several times as they grow, and it is not until the following summer that they undergo the final moult to the pupal stage which lasts for only about two weeks.

Vast numbers of leatherjackets are eaten by birds which search for them by probing into damp soil. It is interesting to note that although damp conditions favour the development of leatherjackets, these same conditions make it easier for birds to dig them out.

A fully grown *Tipula paludosa* larva is about 4cm (1$\frac{1}{2}$in) long, but if disturbed it contracts and becomes shorter and fatter. The powerful jaws are clearly visible, and the overall impression is of a very tough insect. Externally, the pupa shows the developing wings and legs of the adult cranefly. The adult emerges from the pupal case through a long split in the back, generally in the evening or after dark. The fly climbs out of the case and, still limp, climbs up a stem of grass, selects a safe site, and then sits motionless for some hours as the wings expand and harden. During this period it is totally unable to fly.

Some other species *Tipula maxima* is bigger and altogether more attractive-looking than *T. paludosa*. It has a wingspan of 6·5cm (2$\frac{1}{2}$in), larger than any other British fly, but the body is long and slender. The wings are decorated with brown markings, making it an easy species to identify, and contrasting it with most other species, which lack wing markings. Its larva lives in damp places at the edge of streams and ponds, and indeed often lives a semi-aquatic existence, but before pupating it seeks drier soil where there is little risk of being flooded out. The larva is a root feeder, and the adult is sometimes seen in gardens or at a lighted window at night, but the species is nowhere near as common as *T. paludosa*.

The much smaller *Tipula irrorata* has a bluish bloom on the thorax and is interesting because the larvae live among and feed on decaying wood. Members of the genus *Nephrotoma* (of which there are several British species), have yellow and black bodies which look superficially like those of wasps. The larvae of *Nephrotoma* feed in much the same way as those of *T. paludosa*, and one species, *Nephrotoma maculosa*, can be most destructive in vegetable gardens.

IN MEMORIAM: STATELY ELMS

The English elm (below)–for many people a symbol of the British countryside–is sadly now more of a memory than a reality due to the ravages of Dutch elm disease. However it is still in evidence, although the smaller wych elm, also described here, is more widely distributed.

The Elm family (Ulmaceae) comprises 200 species of tropical and temperate trees and shrubs whose best known members are the elms. There are about 20 species of elm, and all are large deciduous trees occurring mostly in the northern hemisphere.

Elm species are difficult to distinguish from one another, but the genus can be recognised easily by two obvious leaf characteristics: one half of each leaf is always longer than the other, and each leaf has double teeth round the margins. The shoots and flowers have less distinctive but equally important features. The leaf shoots are usually arranged in fives, and each is a different shape and size; the terminal bud of most species withers, and the largest leaf comes from the second bud.

The flowers, which appear before the leaves on the previous year's twigs, occur in clusters with the male and female parts together. Each flower is small with no sepals or petals, consisting of a bell-shaped, five-lobed cup of bracts containing the reproductive parts.

The six British species growing in our fields and hedgerows are difficult to recognise because they are similar to one another and most of them hybridise. (You won't find the differences easy to recognise.) In fact, some of the 11 recorded British hybrids are better known than their parent species – it is rare to see a true species in the British countryside.

Elms are best considered in four major groups – the common or English elm, the wych elm, the smooth-leaved elms and the hybrids, the best known of which is the Dutch elm.

The common elm is considered by many people to be the unique symbol of the English countryside and is found elsewhere probably only in Brittany and south-east France. It is predominantly a native of southern England and prefers well-drained valleys in areas such as the Midlands, the Home Counties and the south-west. You rarely see it in the drier parts of eastern Kent and East Anglia where other species, notably the smooth elms, are more common.

The common elm is a beautiful domed tree which has been immortalised in Constable's 1826 painting, 'The Cornfield'. The mature tree has a massive, straight bole extending well into the crown, and a few large ascending branches. The main limbs diffuse into dense, billowing profusions of curled shoots, giving a characteristic overall dark green or blackish appearance which you do not find with other elms.

The bark is dark brown and deeply fissured, forming large, squarish plates. Suckers flourish from buds hidden beneath the bark, especially at the base of the trunk, and crowd around the middle of the tree to give a distinct skirted appearance. The common elm also produces root suckers which can grow at a surprising distance from the parent trees and even form a hedge in some cases.

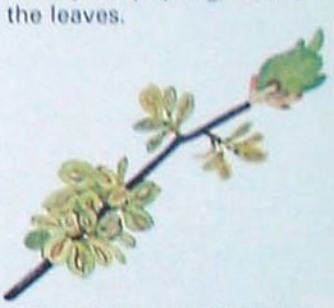
Common or English elm (*Ulmus procera*)
Native, deciduous, grows to 35m (110ft) in hedges, by roads. Flowers Feb, fruits May.

Above: The flowers of the common elm and (below) the fruits. The flowers appear in very early spring, before the leaves.

Normally mature trees are stout with a long densely leafy trunk and billowing crowns representing about a third of the height. However, many trees are cropped by hedge-cutters or foresters along the trunk, giving a naked 'lollipop' shape, rather than the characteristic egg-shape.

In all members of the elm family the flowers are clustered on the one-year-old twigs and appear before the leaves. They are dark red, profuse and regular. The fruits are small and rounded, each one appearing as a dry or fleshy notched membrane surrounding a single seed. Some botanists think the seeds are sterile and cannot germinate, and that the trees proliferate almost entirely from suckers. In reality the seeds lose their germinating capacity after a few days, and do not emerge through the seed coat unless they land on bare soil.

The leaves of the elm are distinctinctive. They are about 10cm (4in) long and 5cm (2in) wide and vary in shape according to



Below: You can distinguish the wych elm by its fruits and leaf stalks: the seeds are always in the middle of the fruits, the leaf stalk is always less than 7mm (¼in) long, and the longer part of the leaf base never overlaps the leaf stalk.

their position on the shoot. They emerge from slender, reddish brown shoots that appear in the hedgerows in April, while those on larger trees appear in May and remain on the tree until November or December.

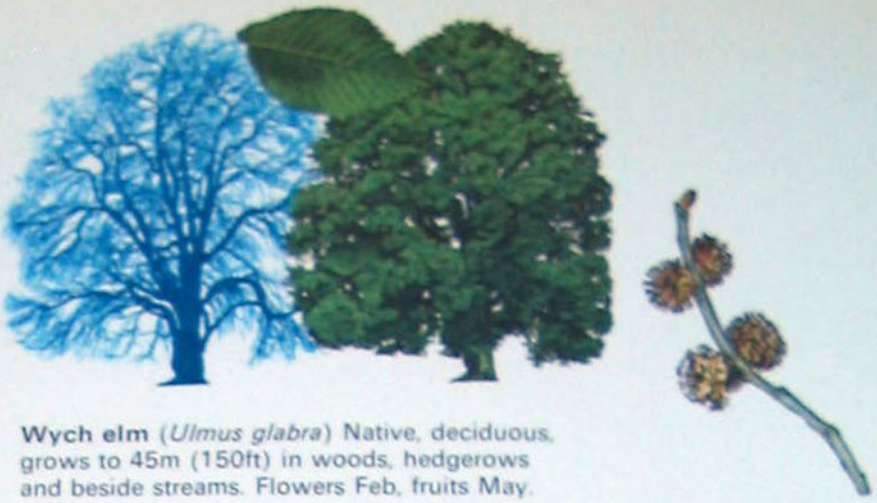
The wych elm can be recognised by a number of characters (see photo caption). Mature wych elms are not as tall as common elms and grow into irregular rounded shapes up to 45m (150ft) high. The lower branches start to arch from near the base of the trunk and the upper branches appear twisted, growing tortuously into the upper crown. The dull grey or blackish bark is smooth when young but becomes brownish-grey, fissured and ridged in mature specimens. The bark is another clue to the identity of mature trees: it appears twisted and parallel-ridged, but never deeply furrowed like that of its close relatives.

The flowers have brightly coloured stamens with crimson or purple anthers and white filaments. The leaves may be up to 16cm (6in) long, on very short stalks. They are bright green and rough above, and downy and rough on the underside.

The wych elm is distributed throughout the British Isles and is the only elm species in Scotland. It is sparse in the West Country and central Ireland, but becomes the most prevalent elm species north of the Midlands and is common in Wales.

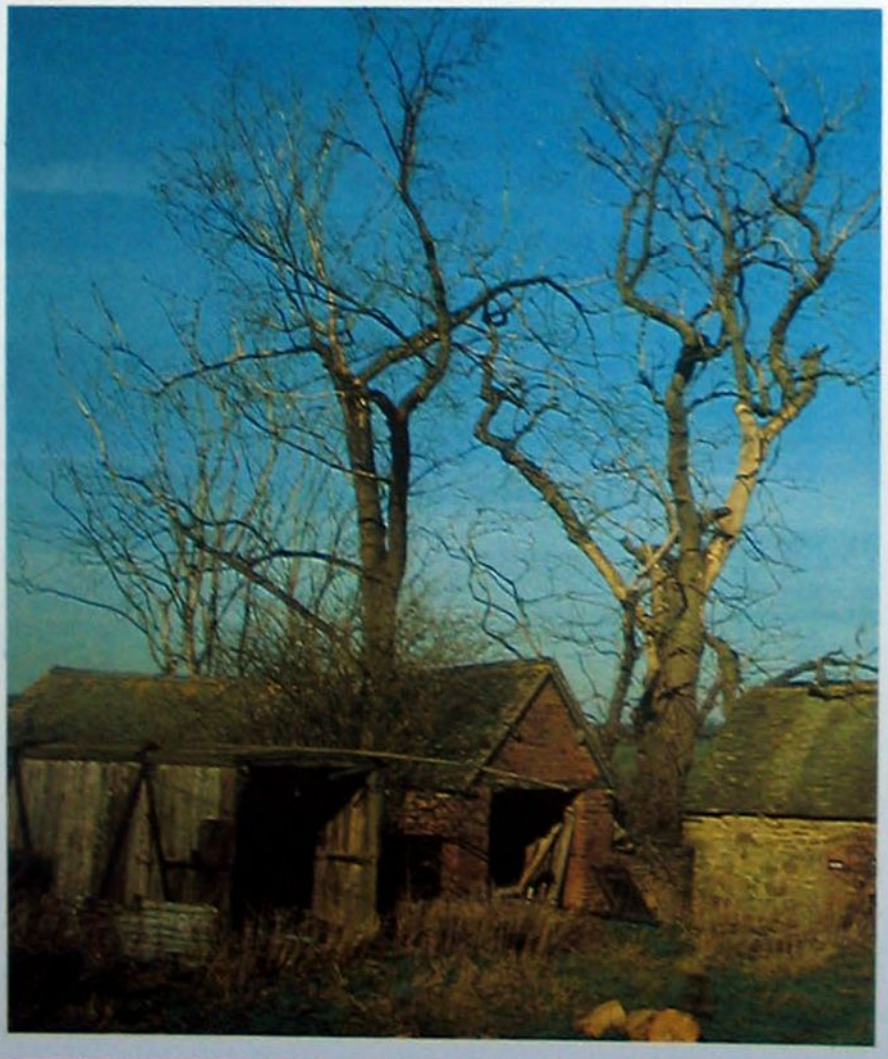
In Scotland the wych elm is a woodland species, growing especially well beside streams. In England it is more of an isolated tree and is often removed wholesale to make way for conifer plantations. In East Anglia you often see it growing in hedgerows.

Popular cultivars Wych elm cultivars have been planted in large gardens and town parks; especially popular weeping cultivars are 'Pendula' and 'Camperdown'.



Wych elm (*Ulmus glabra*) Native, deciduous, grows to 45m (150ft) in woods, hedgerows and beside streams. Flowers Feb, fruits May.

Above: The flowers of the wych elm and (below) the fruits. The green fruits hang in conspicuous bunches in spring.



Dutch elm disease

'Dutch elm disease' is a real misnomer, since it is neither restricted to Dutch elms nor did it originate in Holland. The disease, a fungus infection affecting all elms, was discovered in France in 1818, identified in Holland in 1919, and probably originated in Asia. It was first noticed in the British Isles in 1927 and surveys showed that it was then widespread. The first outbreaks declined, and although 20% of the elms were killed, many partly diseased trees recovered, so the landscape was not damaged too much. In the late 1960s a new killer version of Dutch elm disease hit the British tree population. This epidemic has been so severe that the results have been headline news throughout the 1970s. This time the effect on the landscape has been devastating and the change irreversible. Latest Forestry Commission surveys show that more than 11 million trees have been killed out of a total estimate of 22½ million – more than half our elms have been removed from the countryside. Interestingly, the Forestry Commission surveys have enhanced our knowledge of the distribution of the different elm groups. Disease incidence is greatest in areas with dense elm populations; wych elms and the smooth elms have escaped relatively lightly because of their sporadic distribution. The highest incidence of Dutch elm disease occurs in Sussex, Essex, the Severn-Avon valley and Hampshire, where the common elm was most widespread.

PIRATES OF THE BIRD WORLD

For much of the year great and Arctic skuas obtain food by harrying other birds in flight, ferociously attacking them and forcing them to relinquish their meal.

Arctic and great skuas–large, aggressive, gull-like birds–are migrants that visit the northernmost shores of the British Isles from April to November. They put their exceptionally agile flying skills to good use in robbing other birds of their food.

Arctic skua In size and shape the Arctic skua resembles a middle-sized but rather slim, long-winged gull. The two central tail feathers of the adult birds are greatly elongated into slightly flexible streamers, perhaps half as long again as the body. Although the tail feathers sometimes become broken, this plumage feature is most useful in field identification of adults; it is lacking in young birds.

Colour phases Arctic skuas sometimes cause birdwatchers problems because they can appear in quite different plumages, called colour phases: in one phase the bird is dark brown all over (the dark phase), in the other the body is predominantly creamy white with a dark cap, back, wings and tail (the pale phase). There are numerous intermediate phases with different amounts of pale coloration. The juveniles are always dark all over–a very distinct rich chocolate brown, with grey feather fringes giving the plumage a scaly appearance.

Aerial piracy In view of the difficulties presented by such a variety of plumage colours, it is fortunate that the flight of the Arctic skua is distinctive enough to provide a valuable aid to field identification. The slender build, long whippy wings and long tail make them fast and nimble in flight, capable of astonishing agility in the air. In addition, there is a large white patch in the centre of each wing, visible only in flight, formed by the pale bases of the primary feathers. The patch is conspicuous as the skua twists and turns.

The most common victims of the Arctic skua's piratical assaults are terns and kittiwakes. The unfortunate individual selected by one, or often several, Arctic skuas may be carrying fish back to its nestlings in its beak or crop. The skuas harry the victim relentlessly at high speed, following each twist and turn as it seeks frantically to escape, until at last it is forced to drop or disgorge its catch to get away. The skuas are so agile that they can often catch the food in mid-air before it hits the sea. Young skuas also take part, a habit which shows just how much a part of the skuas' instinctive behaviour these attacks are.

Bully-birds Arctic skuas seem to rely mostly on their sheer bullying capability and expert flight to extract their food; rarely is there much physical contact or actual damage to the homecoming bird, which soon shakes its feathers back into position and returns to its feeding grounds to try again. The attacks are random, too, so that no single pair is remorselessly parasitised and overall their young lose no more than the odd meal.

Above: The great skua is known as the bonxie in Shetland, a word derived from the Norse language and implying aggression and strength, two characteristics this bird has in abundance.

Below: The April-November British range of the great skua. The Arctic skua's range is very similar, except that it can sometimes be found in some of the remoter parts of mainland Scotland.

Great skua (*Stercorarius skua*), 58cm (23in) from beak to tip of tail. Only one colour phase. Relatively late migrant, in Britain from April to November.

Arctic skua (*Stercorarius parasiticus*), 45cm (18in) long from beak to tip of tail. Two main colour phases with numerous intermediate phases. Migrant, in Britain from April to November.

For some of the year at least, and perhaps especially during the winter months, Arctic skuas can, and do, forage largely for themselves. Much of their diet is fish caught on the sea surface or by shallow plunge-diving; on the breeding grounds in years when vole or lemming numbers are especially high, these rodents feature in the birds' diet, as do the eggs or chicks of other birds that have been left unprotected. However, the Arctic skua's dependence on rodents for food is never so great as in the closely related pomarine skua, which has a breeding season diet largely composed of lemmings – to such an extent that, in years when lemmings are low, the pomarine skuas may not breed at all.

Breeding colonies Arctic skuas breed in a relatively narrow circumpolar belt that fringes the northern coasts of North America, Eurasia and the various island land masses in the Atlantic, Pacific, and Arctic oceans. Most breed in colonies, with the colour phases indiscriminately mixed. These colonies are often large, sometimes of hundreds, or even thousands, of pairs. In Britain, the Arctic skua's strongholds are on the offshore islands to the north of Scotland, but occasionally you may see solitary pairs in remoter parts of the Scottish mainland. Elsewhere, the habitat is damp tundra, but British birds nest on open damp grassland or moorland near the coast or, in the south of their range, on open areas of hill country.

Below: Arctic skua with a young fledgling. Note the adult's exceptionally long tail – a helpful feature if you want to identify the adult. Like great skuas, Arctic skuas do not hesitate to defend their territory from other birds and even humans, flying straight at them and attacking them with their strong beaks and webbed feet.

The nest is simple, consisting of a depression in grass or moss, often rounded-off and lined with dried grasses. The clutch size normally varies between one and four olive-brown or olive-green eggs, and incubation and fledging each take about one month. The eggs (and the young that hatch from them) are fiercely defended against intruders, be they buzzards, gulls, foxes or man. All the nearby pairs will take to the wing in defence of the nesting area, but the brunt of the aggression comes from the pair whose territory has been invaded. These birds swoop ferociously at the intruder, coming within inches and often making physical contact.

Summer visitor The Arctic skua is a summer visitor to Britain, leaving during the autumn, and flying south, usually over inshore waters, to winter in equatorial or southern hemisphere waters. If you cannot enjoy the thrilling experience of visiting the remote breeding islands, the best opportunity of seeing all the skuas is at their times of passage. The cross-Channel and Irish Sea ferries provide an ideal grandstand, but a less

expensive view can be had from many headlands around the coast, such as Dungeness, Spurn Point or Portland Bill, all well known as good sea-watching locations.

Skuas are relatively late migrants (like most terns), passing northwards from late April through May. Often they travel in small purposeful parties. In the autumn, their passage is more leisurely, and skuas may be seen offshore at any time between August and November.

The great skua is also best seen in autumn when it migrates south. It, too, winters in equatorial seas. Great skuas are usually seen only in ones or twos, rarely in groups like other skuas. They are easily distinguished from their relatives by their large size (which is very similar to the great black-backed gull), their short blunt tail with only tiny projections of central tail feathers, and their dark brown plumage. There is only one colour phase–brown with buff speckles, relieved by large and conspicuous white flashes in the centre of the wings.

In habits, great skuas can be even more brutal than great black-backed gulls; they may seem ponderous in flight, but this is misleading as they are fast enough to fly down and kill puffins and petrels in mid-air, sometimes using their feet and powerful claws like a hawk. They, too, earn much of their living as pirates (see box feature).

The great skua has a fascinating breeding distribution since it is the only bird in the world that lives near *both* Poles. Indeed, it is rather commoner in the Antarctic than the Arctic, and was recorded very far south indeed by Captain Scott. In Britain, at the southern limit of its northern range, most colonies are sited on islands to the north of Scotland, on coastal cliff tops and moorland.

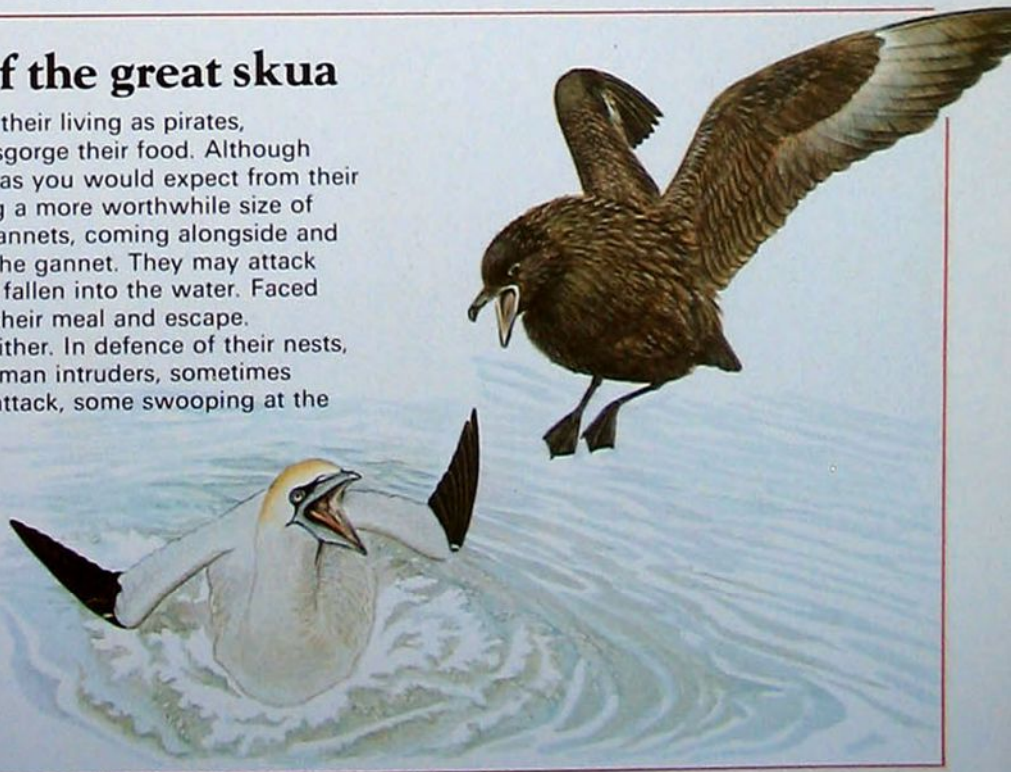
Above: Great skuas are the largest of all the skuas. The adults make such an easy living off piracy in summer near the massive sea bird colonies that they can afford to 'loaf', or stand about, for the greater part of each day.

Right: A clutch of Arctic skua eggs. Incubation may take up to 28 days and the chicks hatch in late May or early June.

The ferocious attack of the great skua

Great skuas, like Arctic skuas, earn much of their living as pirates, attacking other birds and forcing them to disgorge their food. Although they persecute gulls and occasionally terns, as you would expect from their size, they specialise in larger victims carrying a more worthwhile size of meal. They make piratical attacks even on gannets, coming alongside and seizing a wingtip in an attempt to overturn the gannet. They may attack them in flight, or (right) after the victim has fallen into the water. Faced with this treatment, most gannets disgorge their meal and escape.

Such ferocity is not just limited to feeding either. In defence of their nests, and young great skuas will fly directly at human intruders, sometimes operating together from different angles of attack, some swooping at the head, others approaching at ground level before suddenly climbing towards the face. Physical contact with humans is commonplace and painful. Perhaps in the circumstances it is not surprising that the all-over milky coffee coloured down of the youngsters lacks any form of camouflage marking–with such aggressive and effective parental care none is needed.



WILDLIFE AMONG THE TOMBSTONES

Many rural churchyards are ancient and contain a wealth of interesting flowering plants and associated wildlife. As traditional meadows become more scarce churchyards are increasingly valued for their species-rich grassland.

Below: The village of Carrigrohane in Ireland's County Cork has a quiet churchyard with a mature grassland. Its multitude of plant species assures a fine community of meadow-dwelling animals.

Until recently churchyards received little attention from naturalists, but now their value for wildlife is beginning to be recognised. It is clear that in towns churchyards provide 'oases' for birds, insects, small mammals and other wildlife, especially if they are not kept too neat and tidy. In parts of the country where trees and hedges are few and far between they play a similar role. In general, however, the importance of rural churchyards lies in the fact that in many parishes they constitute the last relics of ancient meadow, once one of our richest grassland habitats and now disappearing fast under the pressures of modern farming methods.

The one or two acres of grassland in a country churchyard may have been undisturbed for hundreds of years, apart from the periodic digging of graves for burials. The grass will probably have been cut or grazed annually, but is unlikely ever to have been fertilized, drained, ploughed up or reseeded, in contrast with most of our ancient meadows and pastures which have been 'improved' in this way to increase their productivity. These techniques, while very successful in agricultural terms, have one unfortunate side effect: they transform herb-rich grassland, supporting a high diversity of insects and other invertebrates, into virtual grass monocultures

of little interest to naturalists.

The most productive of the modern hay meadows are those which are ploughed up and reseeded every few years in order to maintain their high yield. These are known as leys. Even if they are left after a while to develop naturally again, they may take hundreds of years to acquire a flora as rich as the original one. This makes the remaining areas of ancient meadow all the more highly valued. There are over 10,000 medieval churches in England alone; taking an average of 1½ acres for the area of a churchyard there could easily be some 15,000 acres of ancient meadow preserved in this fashion.

A rich flora Churchyards contain a wealth of flowering plants. In a recent survey of 80 churchyards in Suffolk, well over 200 different species of herbaceous flowering plants were recorded. Almost half of the 50 species found most often are characteristic of old meadows or pastures. These include cowslip, ox-eye daisy, knapweed, field woodrush and dove's foot cranesbill. Primrose, lesser celandine, cuckoo pint and wood avens are amongst the attractive species fairly frequently recorded. Churchyards also harbour a few rarities–including the man and pyramidal orchids.

One word of warning: not only do some churchyards contain 'garden escapes' such as snowdrops and bluebells; seemingly wild flowers have sometimes been planted deliberately, so a splendid show of daffodils or cowslips may not have quite the significance that it seems to have at first sight.

Bones in the soil The plants you find in a churchyard vary according to the chemistry of the soil, which in turn usually reflects the geology of the area. One noticeable peculiarity of churchyards is that lime-loving species (known as calcicoles) are often more frequent than in the surrounding countryside. These plants include the green-winged orchid, burnet saxifrage, the delicate quaking grass and the gladwin, or stinking iris.

It may be that the calcicoles grow in the parts of the churchyard where bone fragments have enriched the calcium and phosphate content of the soil, and also where material eroded from tombstones or the masonry of the church has added these chemicals to the soil.

Animal habitats Areas of herb-rich grassland, left to grow tall in spring and summer, are inhabited by a multitude of insects and other invertebrates such as slugs and snails. These provide an easy catch for small animals such as hedgehogs, slow worms and the smaller mammals, that move about in the relative safety of the herb layer.

The presence of rabbits, mice and voles is an invitation to larger predators. As well as owls, some of which live on the premises, foxes visit the churchyards, even in towns and the suburbs of larger cities such as Bristol, Glasgow, Birmingham and London.

Under the surface of the earth, moles burrow their way among the graves. They are said to be harmful to agriculture because of their attacks on earthworms among other things, but whether they do noticeably reduce the worm population is hard to tell. The earthworms burrow to a depth of a metre or two and carry upwards the soil they remove in burrowing. Some species eject it in worm casts on the surface, others leave it directly beneath the grass roots. The result of this is a slow undermining of the grave stones, which may sink gradually or lean over as the years pass. Rabbits and moles have a similar effect.

Trees and shrubs provide birds with shade and shelter, cover and nest sites and, in autumn, yield a harvest of fruits. The yew is a

Above: Valerian is a likely plant to find on the walls or even roof of an old rural church. Others are the colourful stonecrops and pellitory-of-the-wall.

Left: The noctule bat feeds on insects in flight for about an hour; just before sunset is the time to watch for it.

Encouraging wildlife

Parochial Church Councils are often willing to do what they can to encourage wildlife in the churchyard. The key to management for wildlife lies in choosing the most suitable time for cutting the grass so that while the churchyard does not become overgrown, the right conditions are there for interesting plants to flower and set seed. Instead of weekly mowing, the grass should be cut only twice or three times a year–this can even result in saving the parish some of its hard-earned cash. The first cut should be at the end of June, the second in October.

nesting tree for goldcrests and spotted flycatchers, and in winter there is no better shelter for any bird to roost than its dense foliage. The red, fleshy outer part of the fruit is eaten by many birds. The inner seed is poisonous, but does not harm the birds as they do not digest it. The foliage of yews, too, is poisonous for livestock, and this is the clue to their being found in churchyards–here they could safely be grown for their wood without endangering cattle, sheep or pigs.

Other wildlife of the churchyard is there by reason of the church itself–noctule bats need some form of enclosed space which they can enter and leave safely, and where doors or shutters do not close them in. Belfries are ideal for this purpose.

Barn owls hunt mainly by hearing, and so the quieter the environment, the better they compete with other predators. Their hearing is highly specialised: the ear is adapted to be particularly sensitive to high-pitched sounds such as the squeaks of field mice. Churchyards in their silence are therefore ideal for this slowly dwindling species.

If any general pattern of the churchyard wildlife can be detected, it is that where more types of habitat are represented–grassland, shrubs, evergreen trees, masonry, eaves and roof vaults, for example–a greater the variety of wildlife will be present.

Clues to the past There are a number of plants which can be used as indicators of the past history of a site. The presence of goldilocks (the woodland buttercup), dog's mercury or the wood false brome grass in a churchyard, for example, suggests that originally the site was adjacent to or even part of a wood. The small-leaved lime is a good indicator of ancient woodland and is sometimes found in churchyard boundary hedges.

Above: The gladwin or stinking iris. The papery brownish red flowers have an unpleasant smell which attracts flies and beetles. The flowers are succeeded by plump pods which split on ripening to reveal rows of fiery orange berries, fully exposed in winter.

Right: Slow worms live in moist places and take to the shelter of crevices under flat stones. They are predators of slugs.

Below: These tombstones are made of limestone and the lichens that grow on them are the bright orange *Caloplaca heppiana* and whitish grey species which include *Diploicia canescens* (formerly known as *Buellia canescens*) and *Caloplaca teicholyta*.

There are other clues to a churchyard's age and history: a round churchyard often indicates a Saxon origin, and a boundary hedge can be roughly dated by counting the number of species in a 30-yard length. Many churchyards have been extended since Victorian times by taking in adjacent pasture or arable land; the richness of the old churchyard flora is often well demonstrated here, for the new part usually has far fewer species, and none of the rarer ones.

It is often noticeable that the older part of the churchyard is raised several feet above the level of the surrounding land. In many cases this can be attributed to the accumulation of material from the centuries of burials. Other churchyards stand higher because they were created on raised sites such as ancient settlements.

Churchyards are usually best visited in May, when many of the spring-flowering species are out and the grass has not yet been cut, but visits at other times of the year will reveal species missed earlier or not previously identifiable.

HARMLESS HORSESHOES

Maligned but harmless, our two species of horseshoe bats are very useful since they eat large numbers of insect pests.

Horseshoe bats are amongst the most agile bats in flight. Their broad wings allow them to fly slowly in confined places and even hover or fly vertically up chimneys or in pot-holes narrower than their wing span. They fly rapidly through the densest scrub. When it comes to roosting horseshoes turn a somersault and grab a tiny projection with long sharp, curved claws and hang upside down in typical umbrella position.

However, unlike the other British bats, horseshoes are clumsy on the ground and on walls. Most bats can crawl and run quickly on the ground with their rear- or side-facing knees and flattened bodies, but horseshoes have barrel-shaped bodies and thin delicate legs which are too weak to lift their weight. This explains why horseshoe bats are found only in certain types of roost–those into which they can fly and hang up without the need to land and crawl.

Navigating noses The distinctive horseshoe-shaped, hairless, fleshy 'leaf' around the nostrils gives the horseshoe bats their common name. This nose-leaf is manipulated by the bat during the production of ultra-sounds used for navigation and food-seeking, so as to focus the sound. It is like a variable focus antenna of a radar dish. The exact purpose of the other elaborate leaf structures above the horseshoe is unknown, but probably relates to finding food.

Feeding When feeding the bats twist and turn continuously in pursuit of food. When food is sparse the bats fly quickly over large areas, searching for concentrations of insects. On cold or windy nights, especially in spring, most food is found in woodlands or wide hedgerows, but in summer more food is caught over pasture, the bats often taking insects from cowpats.

During the first hour after the bat has emerged from its day roost, the greater horseshoe feeds almost continuously but then roosts, usually in an outhouse or barn, for half to three quarters of an hour. If the night remains warm, the bat feeds for two or three further bouts, each lasting about half an hour with similar resting periods. This is followed by a long rest and a final feed often linked with a change to a new day roost an hour before dawn. Occasionally the return to a day roost is delayed until after sunrise. Normally, gregarious lactating females return to the day roost in the night to suckle their young, and solitary roosting males may feed only once each night.

Greater horseshoe bats take quite large food, while the smaller, more delicate lesser horseshoes take correspondingly small prey. In spring, large cockchafer beetles form an important part of the greater horseshoe's diet. In the autumn dor beetles are eaten in huge numbers. At other times, ichneumons, caddis-flies, dung flies and beetles, and various moths are eaten.

Above: Night-flying lesser horseshoe bat. This mammal is usually found in caves, hanging singly in a sheltered crevice.

GREATER HORSESHOE BAT (*Rhinolophus ferrumequinum*).
Size head and body length 58-68mm (2¼-2¾in); weight varies because of hibernation –on average 13-34g (½-1¼oz).
Colour medium to light brown on top with reddish tinges, greyish-buff below.
Breeding season autumn.
No of young one, born in late summer. Eyes open at 8 days. First flights at 21-22 days.
Food mostly beetles.
Predators barn and tawny owls, disturbance by man.
Distribution south-west England, southern Wales.

LESSER HORSESHOE BAT (*R. hipposideros*).
Size head and body length 35-39mm (1¼-1½in).
Colour dark grey-brown on top, paler beneath.
Breeding, food and predators similar to greater.
Distribution south-west England, Wales, Ireland.

Greater horseshoe bat

large ears for receiving sound waves travelling back from objects in bat's flight path
elaborate nose leaf used for directing high frequency sound waves emitted from nose

Left: Hanging free by its toes, a dormant (torpid) greater horseshoe bat envelops its body almost completely with its wings. In this way the bat has some control over its body temperature within the wing. During wet weather any drips of water from the cave walls do not wet the fur but run instead over the wing membranes.

Below: Portrait of a lesser horseshoe bat. The teeth are designed to crush insects such as dor and dung beetles as well as moths and wood-boring wasps. Smaller insects are eaten in flight, but larger ones are taken to a feeding post to be torn into smaller pieces.

Analysis of bat droppings has shown that bats specialise in particular prey each night. This is probably a more efficient method of feeding than attempting to catch different kinds of prey with the extra difficulties of having to use differing techniques for locating, catching and handling the food.

Roosts Horseshoes, in common with most bats, use a variety of types of roost, depending on the season and the needs of individuals. It is known that single greater horseshoes use a large number of roosts in turn throughout the year. The sites chosen depend on the sex and age of the bat, as well as its body weight and breeding condition. Also it seems likely that social factors are involved but little is known. During the mating season some adult males live alone, while during the rest of the year other males, both adult and immature, may share a common roost. Since the same male is found in the same site year after year, competition and dominance may occur.

In hibernation lesser horseshoes are mostly solitary, but they also form loose groups in cellars, caves and, in south-west Britain, often in house roofs. However, nothing is known of their movements between roosts.

Winter hibernation Greater horseshoes hibernate in caves, mines and cellars, or anywhere providing seclusion and fairly stable temperatures within the range of 6–13°C (43–55°F). The bats' body temperature approximates to that of their surroundings. Throughout the winter months the bats waken periodically and usually fly out of the hibernaculum to feed and drink. Sometimes they return to exactly the same spot, or they may seek a new site to continue hibernation. Whichever is chosen, the roosts become progressively cooler as the bats' food reserves become depleted. By March, adult females have lost over one fifth of their body weight, but often juveniles lose about one third.

Springtime awakening In April, towards the end of hibernation, the horseshoe bats wake at more frequent intervals and movement to other roosts increases. By May, adult pregnant females gather in groups in warm sites a mile or two from the nursery site and there is frequent interchange between, and

Above: A creche of baby greater horseshoe bats. When a mother returns she squeaks loudly and her single offspring recognises her voice and replies with vigorous calls until the mother finds it.

investigation of, known sites. Visits to these may be very brief, perhaps just a few minutes in a night. It is thought that it is the way that members of a dispersed colony keep in contact and can exchange information. It is known that bats roosting apart during the day may gather temporarily at night, then by dawn return again to their respective sites.

In spring, when cold nights make food sparse and unpredictable, bats are able to exploit that food more efficiently by gathering in small scattered groups rather than in large clusters. However, clustering may give advantages in conserving energy.

In summer, some males can still be found in roof recesses in caves and tunnels, often near the entrances, while most others move into buildings. The bats prefer to be warm throughout the day but on very hot days when apex roof temperatures exceed 40°C (104°F) the bats spread out and move down to the cooler parts. Body temperatures can exceed 40–42°C (104–108°F) for short periods, but under these conditions energy is rapidly lost. After hot days, the bats usually fly directly to water to drink.

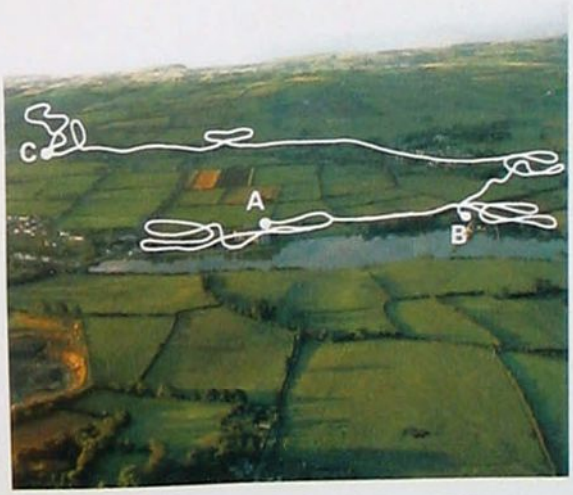
Breeding Mating occurs in autumn, starting in September and probably lasting until Christmas. Little is known about mate selection or whether females are inseminated more than once, but certain males are always present in favoured roosts. It is probable the females know the whereabouts of male roosts and go there when they are ready to mate.

After mating, the female stores and nourishes the sperm in the uterus until spring. Then, usually in May, she ovulates and releases the sperm to fertilise her eggs. The fertilised egg implants in the uterus and because these British bats, although warm-blooded mammals, do not maintain a more or less constant temperature (heterothermic), gestation time varies depending on weather.

A single baby is born within the period from late June to the end of July and exceptionally into August.

Bat highways

Horseshoe bats leave their roost after it is dark to feed. They swoop close to the ground and fly to the nearest cover. A small radio transmitter attached to a bat can track its feeding flight pattern: the one shown on the right is an evening's foraging by a greater horseshoe from its day roost—a castle. Results show that bats establish 'highways' that can be up to 20 miles long, although the straight line distance from the roost can be less than 6.



A Castle day roost. Emerges 8·56pm to feed.

B Shed resting site. Lands 9·47pm, rests.

C Barn day roost. Arrives 12·05am.

TOWERING DOUGLAS FIRS

The Douglas fir has the distinction of being the second tallest tree species in the world – only the Californian redwood grows higher. In the British Isles many of our highest trees are Douglas firs, and they produce some of our best timber.

Right: **Douglas fir** *(Pseudotsuga menziesii)*. Evergreen, introduced from western North America. Planted throughout the British Isles but grows best on lowland sheltered slopes particularly in western regions. May reach 60m (200ft). Flowers March, cones mature in autumn.

The Douglas fir comes originally from western North America where it achieves its finest growth along coastal regions. The Latin name, *Pseudotsuga menziesii*, refers to Archibald Menzies who discovered the tree in 1791 while he was exploring the west coast of Vancouver Island. However, its common name comes from David Douglas, who worked at Glasgow's Botanic Gardens and was sent to North America in 1825 to collect seeds of new species.

The seeds of the Douglas fir arrived here in 1827. At first it was planted purely because it was a fine ornamental tree; as estate owners found it grew quickly and yielded a strong timber, it was soon increasingly grown in plantations, particularly in western regions of the British Isles.

The Douglas fir seems to grow best on gently sloping hillsides in moist, but well-drained, fertile soils. In particularly exposed places the tops may be snapped off by strong winds, and young trees and growing shoots are easily damaged by early autumn or late spring frosts. In favourable locations in south-western England and parts of Wales it grows rapidly, and can reach a height of 23m (75ft) in just 25 years.

Opposite: Douglas fir trees at Bolderwood in the New Forest. British trees are not yet mature enough to produce the superb timber which is imported from North America, although our timber is highly valued. Imported timber is known as Oregon pine.

Below: The new season's growth of young shoots.

Young trees Young Douglas firs have an almost pyramidal outline, their wide spreading lower branches tapering rapidly to the pointed tip. Older trees are characterised by a tall, gently narrowing crown. The bark of young trees is smooth but pock-marked with numerous resin-filled blisters. At this stage the trees are easily killed by forest fires, a fairly common natural occurrence in their native habitat.

Buds and needles The winter buds are quite distinctive and a key aid in recognising the species. They are glossy brown and pointed, looking rather like larger versions of beech buds (see page 47), and they are borne on the tip of each twig or branchlet. They break open during April or May, and the young shoots are a pale yellow-green colour.

The branchlets are arranged more or less opposite each other and are densely clothed in needles, each about 2·5cm (1in) long. The current year's needles are a dull green colour at first, but they later assume the rich, glossy green of their older counterparts. The underside of each needle is marked by two pale stripes along its length. The foliage has rather a soft texture because the tips of the needles are rounded, not stiff-pointed like those of many conifers whose needles consequently have a prickly feel.

Cones The male cones are grouped in clusters on the underside of the previous year's shoots. They are surrounded at the base by a collar of papery scales and are dark red in colour at first but turn yellow as the millions of pollen grains are released in April. The female cones sprout a tuft of long, pointed bracts. They are yellow to begin with, but soon turn crimson or pale pink. They form towards the tips of the branchlets; at first they are held erect, but after fertilisation they droop round the shoots

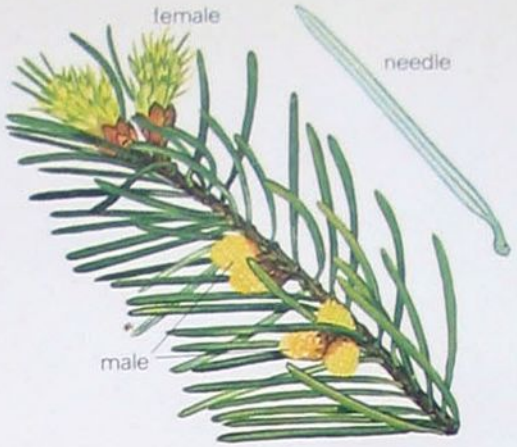
and hang down as they ripen into seed-bearing cones.

The cones (see page 23) are made up of overlapping, rigid, brown scales. Their most conspicuous feature is their papery, three-pronged bracts which previously covered the ovules, one of which protrudes between each scale. The cones mature in one season, and as they dry out in autumn the scales gradually separate to release the small seeds, each attached to a thin, pale brown wing. They lie dormant in the ground through the winter months, and are ready to germinate the following spring.

The seedlings look rather weak and spindly at first, but their frail appearance belies the fact that a strong root system is developing underground. Once this is established, the seedlings grow more vigorously.

Tough timber The wood of Douglas fir is rather coarse, rich in resin, strong and durable. It is widely used for basic structural work in the building industry. It has also been used for pit props, railway sleepers, doors, floors, and for the wooden pallets used for storing and transporting goods.

In North America the Douglas fir is said to live from between 750 and 1000 years. British specimens have so far grown to about 60m (200ft), but we will probably have to wait at least 500 years before we know whether any of our trees will eventually rival native specimens in height.



Above: A shoot bearing clusters of young male and female cones. The underside of each needle is marked by two white stripes along its length.

Below: As the Douglas fir ages, a thick, reddish-brown bark develops with pronounced longitudinal ridges and furrows. This rugged bark is composed of a corky, fire-resistant material which protects the living wood inside the trunk from severe damage in forest fires.

Below: A grove of Douglas firs in the New Forest with rhododendrons growing beneath. Douglas firs are sparsely branched so they let through more light than most other conifer species.

NUT-BORING WEEVILS

If you look at acorns and hazel nuts in autumn you may find some with a small round hole bored in the shell. This is the work of weevils whose larvae live inside the shells and feed on the kernels.

The weevil, or Curculionidae, family has the distinction of being the largest in the animal kingdom; in the British Isles alone there are over 500 species of weevils. These insects are beetles (belonging to the order Coleoptera) and most are characterised by a long protruding snout (rostrum) and clubbed, 'elbowed' antennae. The majority are covered in fine scales, and all are vegetarians – both as adults and larvae. The long snout, with the mouthparts (mandibles) situated at the tip, is used for boring or piercing into plant tissue, especially stems, fruits and flowers, and for feeding on leaves.

Weevil antennae, situated about half-way along the snout, have a long first segment – the scape – which the insect can fold back into channels or grooves – the scrobe – on the sides of the snout. In the species described here – members of the genus *Curculio* – the sexes can be distinguished by the length of the snout: the female's snout is longer than the entire rest of her body and curves downwards, while that of the male is straight and shorter than his body.

Four nut-boring weevils The hazel nut weevil (*Curculio nucum*) has rusty coloured legs and antennae and a black upperside flecked with yellow-brown scales. The adults, out and about in May and June, feed on hawthorn flowers and are locally common in woodland and hedgerows in England and Scotland. This species lays its eggs in young hazel nuts.

Three other members of the genus *Curculio* lay their eggs in acorns. *Curculio villosus*, a black weevil with a red scape, frequents England and parts of Scotland and is about 4mm ($\frac{1}{6}$in) long with grey, hair-like scales. *C. venosus* is very similar to *C. nucum* in appearance, but is exclusively English, being found no further north than Nottinghamshire. Another English species, *C. glandium*, a rusty or brownish coloured weevil 4·5mm ($\frac{1}{3}$in) long, is found in counties south of Derbyshire.

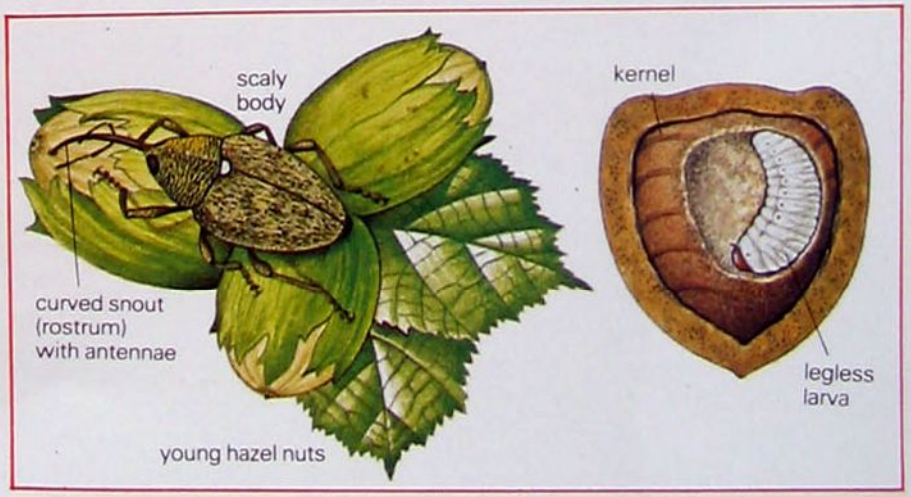
Nursery nuts In early summer the female hazel nut weevil seeks out a hazel tree and finds a young green nut. She bores deep into the soft shell with her snout, then deposits a single egg into the hole.

The larva that hatches within the nut is a stout, limbless grub that is white or yellowish-white with a darker head. It spends the summer feeding on the nut kernel, moulting several times in order to increase in size. At this stage you cannot deduce the presence of the weevil larva in the nut because the small round hole bored in the shell by the female has healed.

In the autumn the nut falls to the ground and the larva gnaws its way out of the shell, leaving a neat round hole, and burrows into the soil to pupate. It stays in the safety of the soil throughout the winter, emerging in spring as a fully-formed adult (imago).

Above: *Curculio venosus* on an oak leaf. This species is about 7mm ($\frac{1}{4}$in) in length. The female lays her eggs inside acorns and the larvae that hatch have a ready-made store of food at their disposal.

Below: The female hazel nut weevil (*Curculio nucum*) (left) uses her long, narrow snout to bore a hole in a young hazel nut. Her larva feeds inside the nut (right) until the autumn, reaching a length of about 10mm ($\frac{1}{3}$in).



MAGNIFICENT SONGSTERS

The clear, musical, flute-like notes of the thrush family are justly famous. On most days of the year from the first light of dawn to late dusk you can hear the vigorous, repetitive phrases of the song thrush, and the more leisurely song of the mistle thrush which continues even in the rain.

Apart from the Shetland Islands, there are few places in the British Isles where you will not find a song thrush; they are a familiar part of our daily lives, and one of the first birds children learn to recognise. The mistle thrush, however, is slightly less widespread and is absent from Shetland and Orkney, and decidedly scarce in the outer Scottish islands.

People sometimes think the two species are difficult to separate. Both are immediately recognisable as thrushes, with medium length, fairly stout bills, speckled underparts, brownish upperparts, long legs and rather large eyes. The mistle thrush is slightly longer than the song thrush but there are other differences as well. The upperparts of the song thrush are a warm brown, and those of the mistle thrush a distinctly greyer brown. You can see these features quite clearly when the birds are in flight. As the birds pass overhead, look at the axillaries (the feathers covering the 'armpits'): they are a flaming orange-yellow in the song thrush and white in the mistle thrush. The tail of the song thrush is a uniform brown but the mistle thrush has whitish tips to the outer tail feathers. The underparts differ as well: both birds have dark brown breast spots on a pale background, but the spots of the mistle thrush are bigger, more rounded, and altogether bolder, on a paler background.

Rich song All members of the thrush family sing loud, clear, musical flute-like notes. The special qualities of the song thrush are its vigour and repetition. The bird sings the same notes two, three, even five or six times–sometimes you could swear that it is practising a choice phrase. The song thrush uses favourite note sequences time and time again, interspersed with numerous other notes and phrases, many of them mimicking other birds. Some species, such as the chaffinch, sing rather poorly at the start of the season and their performance steadily becomes more polished, but the song thrush sings well right from the start, and some people think its performance is enriched with age.

The mistle thrush has a more limited song–a sequence of a few notes in permutation. It is loud, clear, full, rich and leisurely, and could be monotonous if it were not for its fine quality.

Aerial song posts Members of the thrush family like to sing from high song posts, and song thrushes and blackbirds have been quick to commandeer television aerials. The mistle thrush prefers to sing from the topmost branch of a tall tree, and its readiness to do so even in heavy rain has led to its widely used folk name, stormcock. In most

Mistle thrush (*Turdus viscivorus*) 27cm (10½in) from beak to tail; distribution widespread in all areas apart from some northern parts of Scotland. Resident.

Song thrush (*Turdus philomelos*) 23cm (9in) from beak to tail; distribution widespread throughout the British Isles around houses, in woods, parks, gardens. Very common. Resident.

Right: Song thrushes excel in cracking snail shells and extracting the flesh, thus providing themselves with a valuable source of food when drought drives the worms deeper. They beat the victim against a stone or hard surface ('anvil') to break it.

years song thrushes start to sing in November – even October – and do not stop until July or later. The mistle thrush does not start singing until the turn of the year and usually ends at the beginning of June.

The call notes of the two species are quite different. An alarmed song thrush says 'tchouk tchouk . . .', the notes coming faster and closer together when the bird is particularly anxious. The mistle thrush has a loud, vigorous call which sounds rather like a football rattle.

Habitat preferences Although the two species are frequently found in the same acre of ground, they have different habitat preferences. Song thrushes are at home in gardens and shrubberies, and you will probably see more nesting around houses than in farmland. You might hear eight or nine individuals on a half mile walk on a mild November morning, which suggests a density of one bird every hundred yards or so.

Mistle thrushes are always more thinly distributed and seem to require much larger territories. They too penetrate urban areas, but they tend to favour parks, cemeteries, and playing fields rather than gardens. Large mature gardens and parklands, on the other hand, are typical habitats for them. In the breeding season you may find them in woodlands and even conifer plantations, so long as there are grassy rides or adjacent grasslands for spring feeding.

Song thrushes tend to favour the same type of habitat in winter and summer, although the higher ground is vacated before the cold winter weather sets in, and a proportion of the population migrates. In northern Britain the migration is chiefly to Ireland, but those individuals that migrate from the south make chiefly for Iberia. In harsh winters, non-migrating song thrushes may suffer so severely that they are obliged to carry out a cold-weather movement – an emergency migration. The small proportion of song thrushes that migrate usually go to France.

Above: A juvenile song thrush can be distinguished from an adult by its speckled back plumage. Song thrushes nearly always sing from an elevated song perch.

Song thrushes are solitary and flock together only on migration. Mistle thrushes, on the other hand, tend to move about in family parties at the end of the breeding season; the parties later amalgamate to form loose flocks of up to 100 birds which roam the countryside together, penetrating even wild upland country in their search for food. During midwinter the flocks split up and the birds occupy their territories for the start of a new breeding season.

Superbly structured nests Mistle thrushes tend to start breeding two or three weeks earlier than song thrushes, work on the nest often starting before February is out. In both species the hen alone builds the nest, which is well-engineered and incorporates grasses and mud for bonding. The nest of the song thrush is especially beautiful – smooth, symmetrical, and rather like the inside of a coconut shell.

The song thrush is versatile and adaptable in its choice of nest sites, hiding – or sometimes failing to hide – its nest in bushes and shrubs. Its willingness to live so close to man enables it to exploit such unlikely sites as the top of the cistern in an outside lavatory, although

Left: An egg and some chicks of a song thrush. This species is unique among European birds for its habit of plastering the inside of its nest. The plaster is made from dung or rotten wood mixed with saliva.

Below: A song thrush removing a faecal sac from its young. The parent does this to keep the nest clean, depositing the sac some distance from the nest.

natural sites greatly predominate.

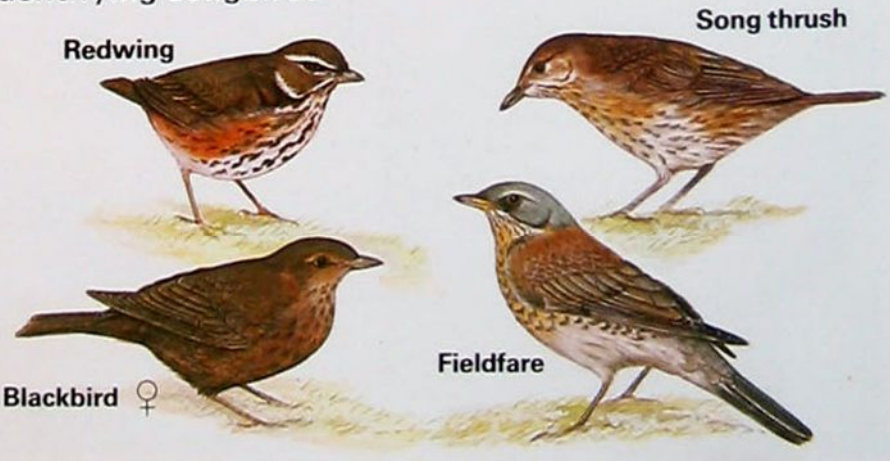
The mistle thrush normally builds its nest in the fork of a tree, perhaps 7-9m (20-30ft) up, and remarkably well hidden. From this vantage point the incubating female keeps a watchful eye, crouching low if she suspects she is being observed. Mistle thrushes are fearless in the defence of their nests and young, and do not hestitate to tackle birds much larger than themselves. Apart from egg-stealing members of the crow family, their chief avian predator, and the song thrush's as well, is the sparrowhawk. Peregrines occasionally eat them.

There are four or five song thrush eggs in a clutch, each a beautiful blue thinly speckled with black. They are incubated by the hen alone, and take 13-14 days to hatch and a similar period to fledge. A second brood is often followed by a third. The mistle thrush may lay three to six eggs, though four is normal. Their background colour varies from cream to pale greeny-blue, and they are dramatically blotched and speckled with sepia. The incubation period is the same as for the song thrush, but the young may take a day or two longer to fledge. The juveniles develop speckled back plumage which they lose when they become fully mature by the following spring.

Feeding habits Thrushes feed on fruit for much of the year; the rest of the time they rely on worms, insects and other invertebrates. You often see them feeding on lawns: a quick hop forward to focus more accurately, using monocular vision, (not to listen); a few vigorous pecks, and the worm is dragged out. Song thrushes crack snails on their 'anvils' (stones), and during snow cover they ferret about for food in hedge bottoms and even among the marram grass along the coast. Mistle thrushes are more reliant on worms and insects, often feeding in the centre of fields. In a sense the feeding habits sum up the temperaments of the two species: the mistle thrush bold but wary, even self assertive; the song thrush more retiring, and often unobtrusive.

Above: A mistle thrush feeding its young. Fruit is an important part of the diet of both species, but particularly of the mistle thrush which favours mistletoe berries—hence its name. In northern Britain rowan provides tasty berries and even isolated trees far up on the fellsides may be visited and stripped bare. Holly, yew, hawthorn and, later in the winter, rose hips and ivy berries are also eaten by both species.

Identifying songbirds



BOGGED DOWN WITH SPHAGNUM

For everyone who thinks bogs are uninteresting, David Bellamy brings to life one of the often unnoticed but prominent bog plants of our countryside–Sphagnum moss–a constituent of the peatlands that cover 93 million acres of the earth.

Above: Sphagnum moss growing in a stagnant pond. The Sphagnum gradually encroaches on the pool by absorbing large amounts of water to create a bog. Peat is eventually formed from the accumulation of decayed tissue that collects there.

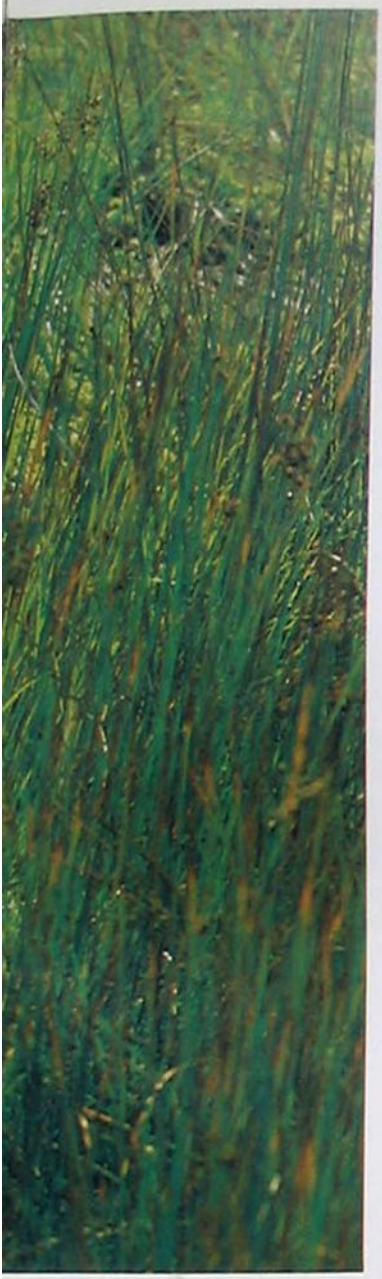
The world's peatland resources are to a great extent made up of the living members and dead remains of a genus of mosses called sphagnum–an important group of plants. I must admit to a certain bias in their favour for I have spent many of my most absorbing and enjoyable hours studying these plants.

The Sphagnum bog mosses have a number of unique features which make them easy to distinguish from the other sorts of moss, at all stages of their complex life cycle.

Habitat Sphagna are only found growing in wet places and usually where the ground is permanently waterlogged. They also grow as epiphytes–that is, stuck on to the trunks and branches of trees–in the woodlands of the wetter western coasts of Ireland, Wales and Scotland.

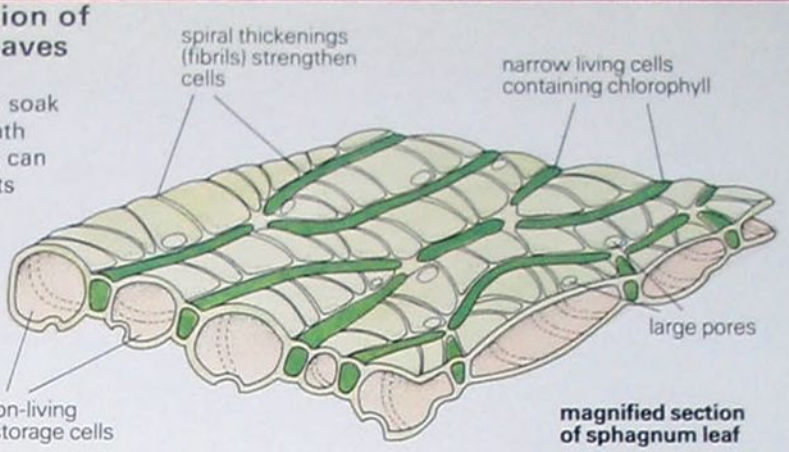
Structure The plants have very weak and brittle stems and cannot stand up on their own, hence they are always found growing in dense carpets, or often as swelling hummocks, their packed stems providing mutual support. A close look at a single stem reveals that the branches arise in whorls, several sprouting out at each level, the separate branches themselves being covered by overlapping leaves.

Closer inspection, using a good lens or microscope, shows that each leaf (though made up of a single layer of cells, as in all mosses) consists of two distinct sorts of cells.



Water retention of Sphagnum leaves

Sphagnum leaves soak up water like a bath sponge; the plant can absorb 25 times its own weight of water.


spiral thickenings (fibrils) strengthen cells
narrow living cells containing chlorophyll
large pores
large non-living water storage cells
magnified section of sphagnum leaf

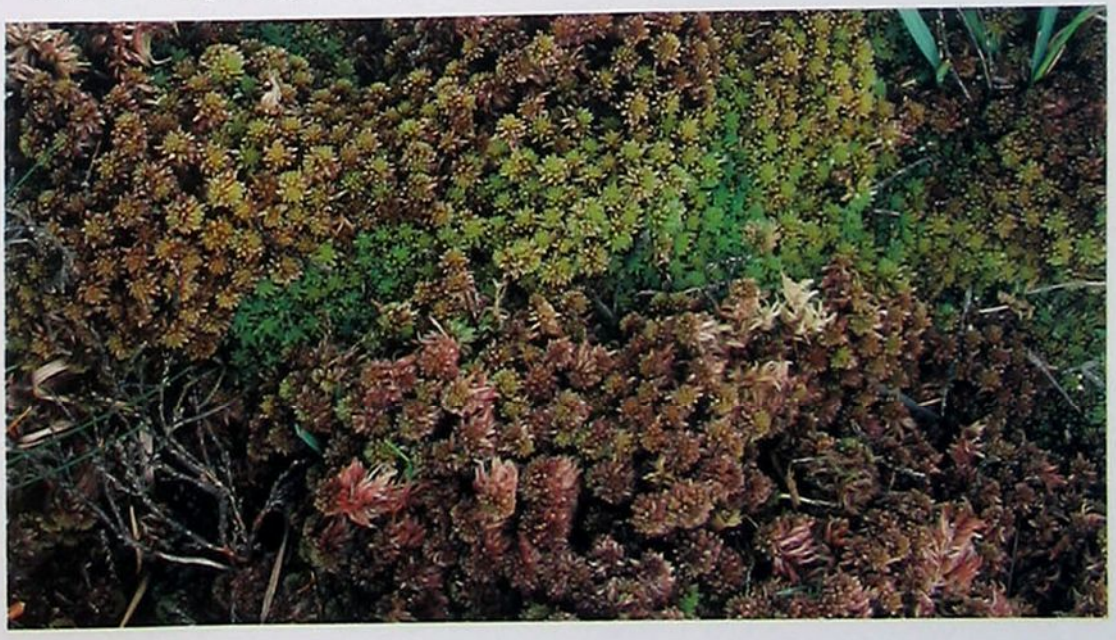
First, there are large, dead, colourless ones, the walls of which are strengthened with tough, spirally arranged tissue called fibrils and pierced by large pores which connect the empty lumen or cavity of the cell to the outside world. These are separated by, and partly overlay, narrow living cells which contain the green pigment chlorophyll and carry out photosynthesis. This unique structure allows the leaves to act as tiny water storage reservoirs, carrying their own water supply ever upwards as they grow (see diagram).

Ecological cycle The water held in the moss mat performs two important functions. First, the tops of the Sphagnum plants need it in order to survive. Secondly, being stagnant and without oxygen, it shuts the lower parts of the plant off from the oxygen-rich air above. In consequence when the plants die they do not rot but remain in the form of peat. This peat layer shuts the living plants off from any supply of nutrients from the mineral-rich soil beneath, thus they come to rely on the meagre supplies brought in by the rain and on an efficient recycling economy, deriving their nutrients from the dead plants rather than the soil.

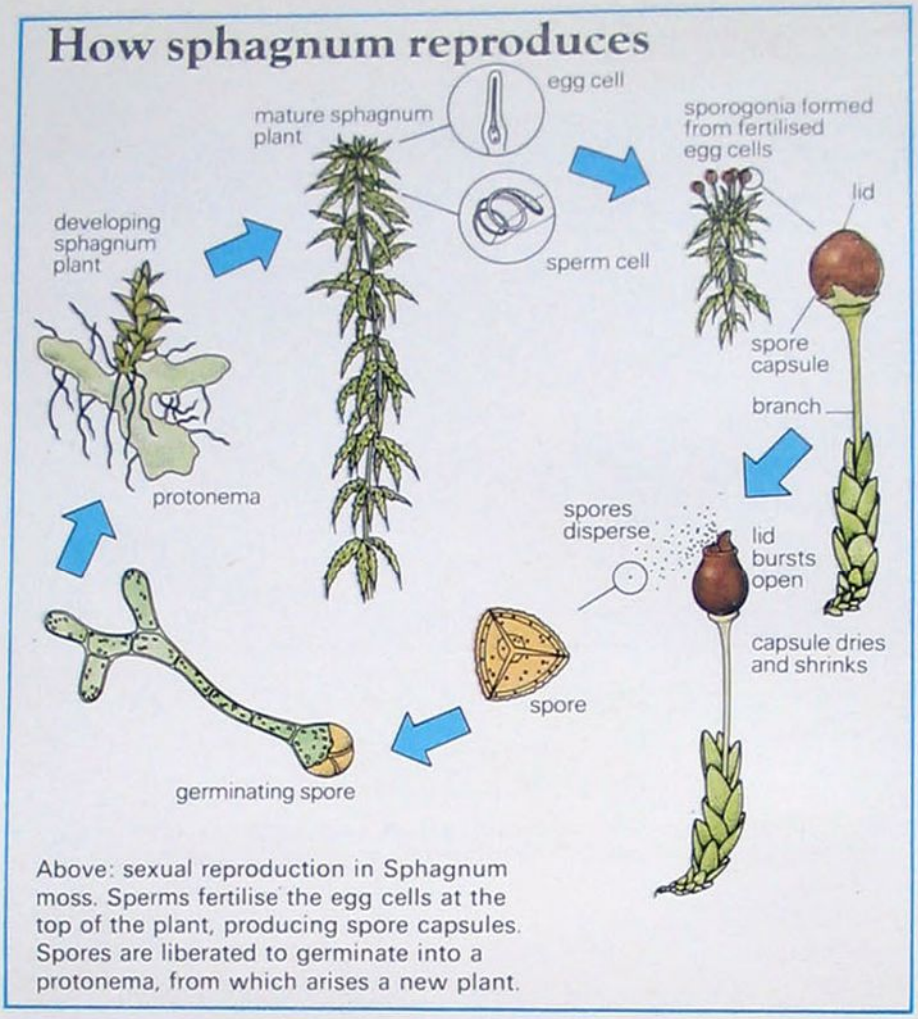
Like all living things, Sphagnum moss produces acidic wastes as by-products of its life processes. In bogs, these accumulate in the stagnant water of the moss mat and, in the absence of supplies of basic minerals the habitat sours and becomes more acid. When it comes to living under these testing conditions the Sphagna are perfectly adapted to an environment they themselves help to create.

Reproduction At certain times of the year, the organs of sexual reproduction appear on the Sphagnum moss plant. These are so small that they can only be seen with the aid of a microscope. The antheridia (male sexual parts) produce sperms which can swim through the water attracted by chemicals produced by the archegonia (female sexual parts). The fertilised egg does not develop into another moss plant but into a capsule inside which are many spores. This is the saprophytic, or spore-bearing generation.

The capsules of the bog mosses are unique among mosses in that they do not have their own special stalk or seta. They are carried slightly above the parent plants on a bare branch called a pseudopodium which is part of the gametetophyte or gamete-bearing generation (Gametes are male sperm cells and female egg cells.) The capsules are brown



Right: The blanket bogs are never dull and monotonous—the Sphagnum carpet forms an ever-changing patchwork of greens, yellows, oranges, pinks and reds, like this one pictured in June. Sphagnum forms three types of bogs: blanket bog, which is found on stagnant water on wet moorland; valley bog, which appears in marshy areas with flowing water; and raised bog, which appears on the surface of choked-up fenland. This creates acidic conditions in which Sphagnum thrives.



Above: sexual reproduction in Sphagnum moss. Sperms fertilise the egg cells at the top of the plant, producing spore capsules. Spores are liberated to germinate into a protonema, from which arises a new plant.

and spherical and close examination reveals a small lid which looks not unlike the top of a schoolboy's cap minus its peak. Beneath the lid there is a packet of spores which lies on top of a mass of thin-walled cells. As the spores ripen the capsule loses water and shrinks, collapsing the thin-walled cells. Shrinkage continues, distorting the capsule as the pressure builds up inside. The lid then flies off with a distinct 'pop' and all the spores are dispersed on the wind.

Spores that fall on suitable, boggy ground germinate to form an intermediate stage called a protonema, which is different in structure from the protonema of other mosses, being a small, lobed flattened structure rather than the normal filament. It bears numerous vegetative buds on its surface, which in time produce a new bog moss plant, just like the one which started off the whole life-cycle, two generations before.

Conservation Unfortunately, all is not well in the world of the bog mosses. They, like so much else in our living countryside, are under attack. Exploitation by mining the peat for chemical, industrial and horticultural purposes takes the greatest toll. The current world rate of peat extraction is 90 million tons per year, most of which is used as an energy source. The resultant cut-away landscape is more often than not a wet 'desert' of little use to man or nature. Reclamation and drainage of peatland for forestry and marginal agriculture is an increasing threat, as is mismanagement of our upland sites in these days of rising labour costs.

The exciting thing is that if the sites are handled in the right way much of their diversity and interest can be maintained, regeneration is possible and so the peatland and the peat can be regarded as a renewable resource.

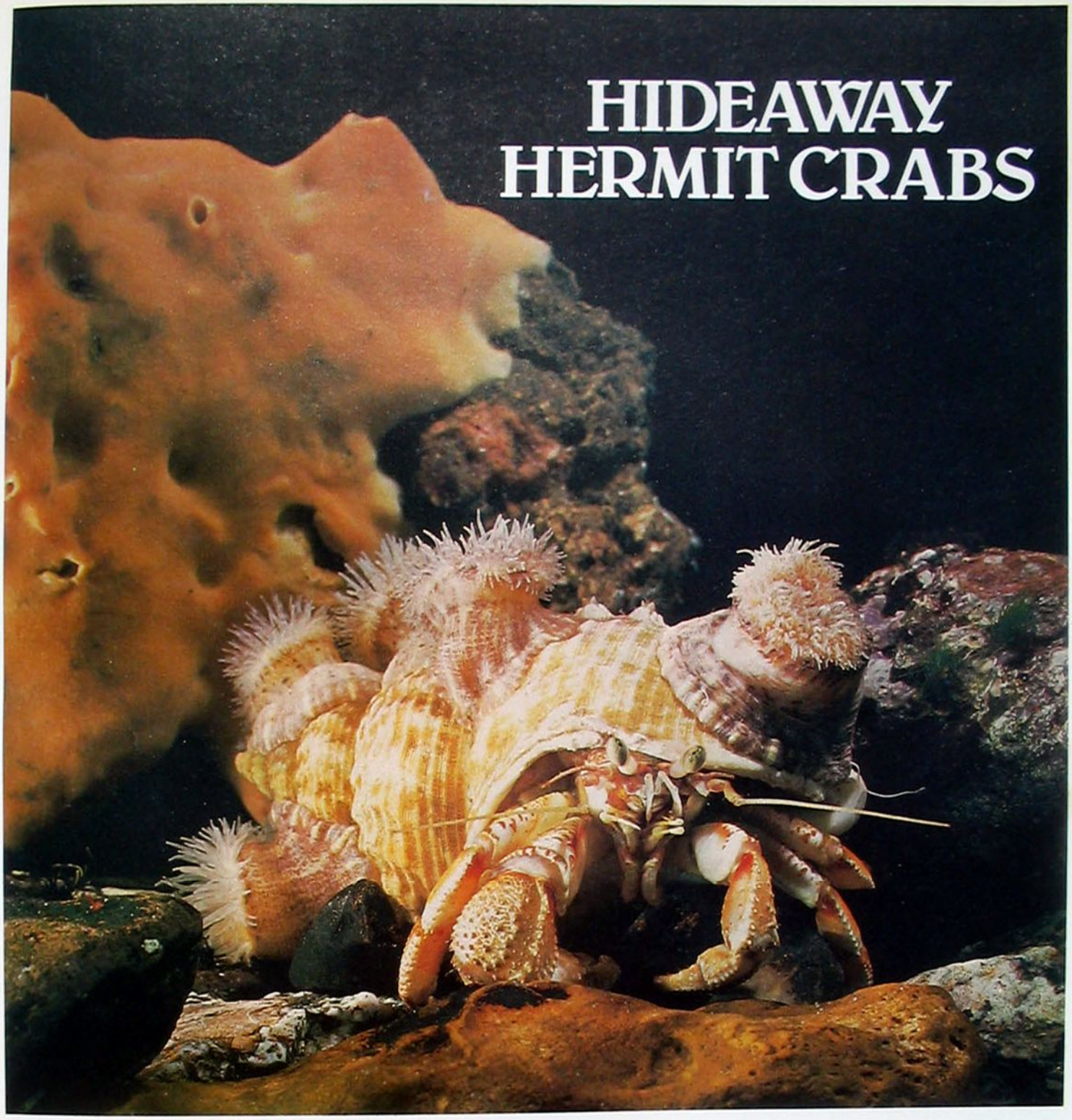
The world of the bog mosses may not appeal to everyone, but it is well worth a thought. If you do decide to join the ranks of the 'peatniks' there is the British Bryological Society to help you on your way. One thing I can guarantee is that wherever you go in the world, Sphagnum won't be far away.

Left: *Sphagnum tenellum* is a delicate moss which is found throughout the British Isles. The domed, brown spore capsules here are still intact, but when they explode, usually in early summer, they make a faint popping sound.

Below left: *Sphagnum fimbriatum* is found in wet woodlands and shady places in fens. The slender plants branch out to form delicate rosettes with pointed tips.

Left: *Sphagnum magellanicum* is a colourful variety of sphagnum, found on acid bogs. It is rare in the south and east of England, and produces spore capsules at infrequent intervals.

HIDEAWAY HERMIT CRABS



The common hermit crab *Pagurus bernhardus*, is a familiar sea shore animal. It lives in rocky places on the lower shore and in shallow water all around the British Isles. Adult hermit crabs reach up to 11·5cm (4½in) in length. Another species *Pagurus prideauxi*, is quite common in sandy shallows, but is rarely found on the sea shore. Five other species have been recorded from British waters at various times, but they are all uncommon, rarely coming inshore.

Pugnacious predators Hermit crabs are crustaceans and like other members of this group, such as true crabs, lobsters and prawns, they have for the most part a tough shell or exo-skeleton, reinforced with chalk-like material. This is not present on the soft abdomen. They are scavengers and predators and are rather pugnacious, sometimes fighting amongst themselves. They live mainly by catching sick or injured animals, or by scraping attached organisms from the rocks. Their powerful nippers and mouth parts are ideal for this purpose.

Adopted home Unlike their relatives the lobsters and true crabs, hermit crabs require an additional shell because the hind part of the body – the abdomen – which houses part of the gut and other structures, is covered only by a thin skin and lacks the hard chalky shell found elsewhere. By concealing the soft abdomen inside a disused shell,

Above: A common hermit crab (*Pagurus bernhardus*) living in a whelk shell, which is also a home for the sea anemone *Calliactis parasitica*. Both crab and sea anemone benefit from the relationship; the crab is protected by the anemone from attacks by predators, and the anemone is carried around the sea-bed so it can trap food with its tentacles.

Above: *Pagurus prideauxi*, its adopted shell virtually invisible under the cloak anemone *Adamsia palliata*. As the crab grows, so does its partner. The base flaps of the cloak anemone secrete a horny tube which effectively extends the aperture of the snail shell, making it longer and wider to accommodate the growing hermit crab.

Living together

Some animals or plants do not lead an independent existence; instead they live in association with other unrelated species. Sometimes these associations benefit one partner only, and if the arrangement does not adversely affect the other partner, (as in the case of the hermit crabs and their resident anemones), it is termed **commensal**. Where one partner exists to the obvious detriment of the other (as, for instance, lice living and feeding on the blood of birds), then this is known as **parasitism**. **Symbiosis** is where both partners benefit mutually from the arrangement (as in lichen).

such as that of a winkle or whelk, the hermit can be certain of protecting its delicate parts.

The head and thorax of the hermit crab are joined together in one section of the body forming the carapace. This carries two pairs of antennae, the various mouthparts, a pair of stalked eyes and five pairs of legs. The first pair of these legs has powerful nippers, the second and third pairs are generally strong and used for walking, while the fourth and fifth pairs are somewhat reduced and modified for holding the animal in its adopted home.

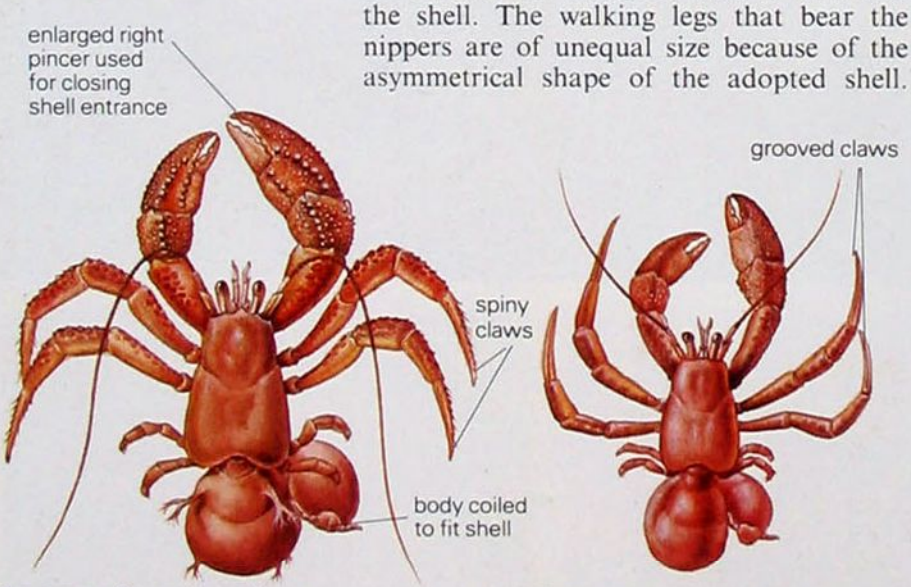
Modified body structure Using a second-hand home has both advantages and disadvantages. The basic crustacean body form has had to be modified considerably; the hermit crab's abdomen is not straight, as in the lobster, but coiled so that it fits inside the shell. The walking legs that bear the nippers are of unequal size because of the asymmetrical shape of the adopted shell. The right nipper is larger and is used to close off the entrance of the shell when the crab withdraws into it. The second and third pairs of walking legs have to be strong and well-developed in order to move both the animal and its home around. Because of all these modifications, the loss of two pairs of effective walking legs and the weight of the snail shell, hermit crabs cannot scuttle around quickly like some of their relatives, the true crabs, and neither can they swim.

Moulting Another problem faces the hermit crab as a result of its life-style–what to do when it grows. All crustaceans have a growth problem in any case. Because their bodies are contained inside a hard shell, they cannot grow continuously like many other organisms. Instead, they have to grow in stages, by shedding their old shell, expanding in body size and then growing a new shell–a process known as moulting.

Prior to moulting the animals generally hide themselves away in a secure place. Then, the movement of blood and other fluids around inside the body causes the shell to burst at a special weak point and the animal climbs out. The soft body, already encased in a new, but soft shell, now expands a little to take on the new size. The new outer covering hardens in a matter of a few hours and life resumes as normal. Life is dangerous while the exoskeleton is soft, as the animal is especially vulnerable to predators.

For the hermit crab, such a process is even more complicated. The hermit must first climb out of its adopted shell and then moult, returning immediately to the shell–if it is still big enough. If it is not, then a new one of suitable size must be found.

Protective partnership Some hermit crabs have developed unusual solutions to the problem of finding a new shell. The best one seems to lie in forming an association with another organism which will protect the



Common hermit crab (*Pagurus bernhardus*) Length up to 11·5cm (4½in). Pincers large, coarse texture. Right pincer larger. Walking legs have spiny claws. Carapace grey-red.

Pagurus prideauxi. Length up to 6cm (2½in). Pincers slightly bristly. Right pincer larger. Walking legs have grooved claws. Other legs much reduced, to hold on to shell. Carapace brown-red.

crab. Hermit crabs have entered into partnerships with a variety of organisms; the most interesting arrangements being those concerning sea-anemones.

The common hermit is sometimes found in association with the commensal anemone *Calliactis parasitica*. Despite its name, *Calliactis* is not a parasite, but is found living on the outside of the snail shell, in partnership with the crab. Some hermit crabs may carry several of these fairly large anemones around with them. The anemones certainly gain more food as a result of this arrangement as not only are they transported around to new feeding sites, but they also obtain left-over food from the crab. It seems likely that they in turn protect the crab from predators such as the octopus, using the stinging cells on their tentacles. Scientists have observed that common hermit crabs seem well aware of the advantages of having sea-anemones on their shells, and when they change shells, the anemones are carefully transferred. Although *Calliactis* sticks tightly to the shell for most of the time, it can be induced to let go so that transfer to a new shell can be quickly effected. Exactly how the crab achieves this is not known, but it probably stimulates the anemone in a special way.

The hermit crab *Pagurus prideauxi* lives with an anemone that shares its food, the cloak anemone. This species is so-called because of the wide flaps at the anemone's base which are wrapped around the snail shell occupied by a small hermit. This anemone is highly modified for this sort of existence, and is found only with the hermit crab, never on its own. (It is not found living in association with the common hermit, *Pagurus bernhardus*.)

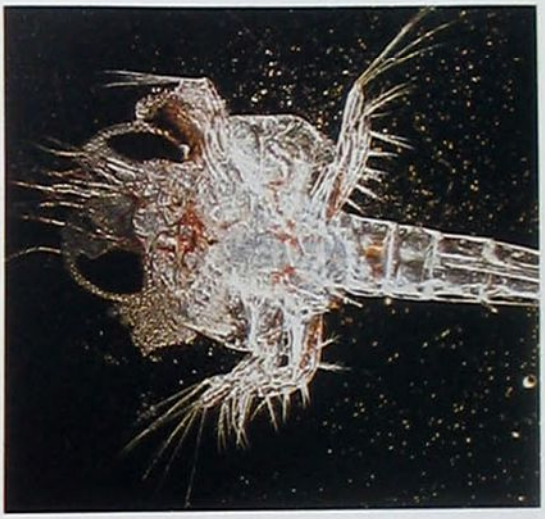
The anemone probably collects some food from the sea-bed as it is dragged around by the crab, but it almost certainly gets food from the crab too. Hermit crabs are rather messy eaters, tearing their food apart with their nippers and mouth parts, so that quite a lot of small particles fall free and are available to the anemone. Other types of anemone, notably the encrusting anemones, have achieved a similar relationship with other hermit crabs.

One sponge species, the sulphur sponge or sea orange *Suberites domuncula*, sometimes grows over the snail shells occupied by the common hermit crab, gradually dissolving away the snail shell, leaving the crab's body encased in a thick layer of growing sponge. It is not clear what advantage the sponge derives from this relationship; it seems to live purely for the crab's benefit.

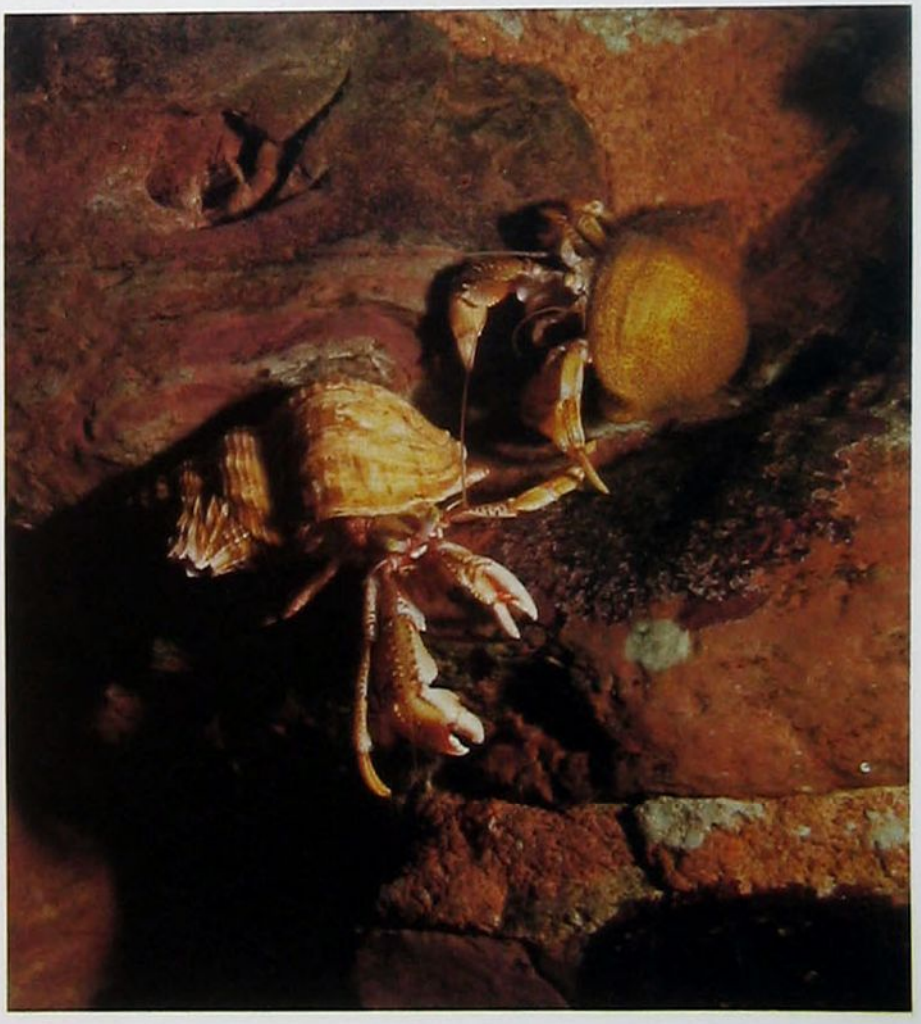
Other relationships Apart from anemones and sponges, hermit crabs are sometimes associated with a number of other animals. A polychaete worm is sometimes found inside the shell, emerging to share some of the crab's food. Various other worms may live on the outside of the shell, along with barnacles and other organisms. Some hermit crabs can also be found with a parasitic barnacle, *Peltogaster*, growing on the side of the abdomen. This parasite feeds on the contents of the hermit crab's body and appears as a yellowish lump on the underside of the tail. It can only be seen if the crab is removed from its shell, (an operation which has to be performed very skilfully if the crab is not to be injured.)

Victorian naturalists sometimes kept hermit crabs in marine aquaria, providing them with glass shells so that they could be seen inside their protective housing, together with any other animals, such as the polychaete worm, living with them.

When the hermit crab's eggs have been fertilised, they are carried by the female until they develop into the swimming larval form (below). Although crustacean-like, this hardly resembles a hermit crab at this stage, and the larva must pass through an intermediate stage before it settles on the sea-bed as a juvenile hermit crab.



Below: Hermit crabs viewed from above as they scuttle into a rock crevice. As hermit crabs move around rather awkwardly they generally retreat inside their homes when danger threatens. However, they do not suffer from their restricted life, being widely distributed in large numbers around our coasts.



A WALK THROUGH BEDGEBURY PINETUM

Bedgebury has good specimens of an enormous range of conifers and is one of the world's most comprehensive evergreen collections. As you walk along the grassy paths among its hundreds of contrasting trees, you can also enjoy the serenity and seclusion of this quiet spot in a corner of Kent.

The National Pinetum was founded by the Forestry Commission and Kew Gardens jointly in 1925. It had been found that Kew was too close to the air pollution of London for conifers to grow successfully, so Bedgebury was chosen as reasonably close to a station–Tunbridge Wells, in fact 19km (12 miles) away–with good services to London, cleaner air and a suitable type of land for growing conifers.

A number of large 50-year old conifers (including Scots pines) scattered through chestnut coppice already existed at Bedgebury. This formed good shelter and background for new planting. There were also two streams and a lake. The soil is generally a silty sand which is not rich in nutrients, but there are some areas with a better woodland soil. This combination provides most conifers with a site suitable for good growth; the only uncongenial feature is that the two main valleys (Spruce Valley and Cypress Valley) collect cold air on calm nights and can register a frost in any month of the year.

From the entrance (**1**) the view is of a ridge topped by old Scots pines, below which stands the spruce collection, on the spring-fed slope and by the stream. The wide upswept crowns of Alcock's spruce, from Japan, are prominent and contrast with the tall slender Serbian spruces behind.

On crossing the stream, by a group of fine Likiang and Dragon spruces from China, you enter Dallimore Avenue (**2**), which lies between spruces on either side. On the right your attention will be attracted by the very pendulous Brewer spruce and several forms of the blue Colorado spruce. Bear right past an old monkey-puzzle and cross a ditch to the bank of the lake.

Marshall's Lake By the waterside is a small wood (**3**) of swamp cypress, introduced from the eastern USA; standing among the swamp cypresses there are three specimens of the similar-looking dawn redwood from China. Both species are deciduous redwoods. The swamp cypresses, planted in 1929, have started to grow the woody humps rising from their roots that are often known as 'knees'. The dawn redwoods are younger, having been added in 1955, and are in fresh green leaf in April, while the swamp cypress hardly shows green until June. Both appear in splendid fiery colours in October.

The route follows the lake by mature pines, western hemlocks and large rhododendrons, coming out on a bank planted with silver firs and a red maple. On the upper slopes of the bank are fast-grown specimens of Low's, red, noble and grand firs, all from western North America, planted in 1925 and some of them over 30m (100ft) tall.

Leyland cypresses Along the top is a line of Leyland cypresses (**4**) planted in 1935. The Leyland cypress is a hybrid between the Monterey cypress, which grows in a hot, dry cliff habitat in California, and the Nootka cypress, which is native to the cool wet mountains stretching from Alaska to Oregon. The Leyland is therefore able to grow well whatever the weather.

Across this avenue is a group of larches, of which the best are the Polish and Sudeten forms of the European larch, and there is a good specimen of the Western larch, native to British Columbia, Washington and Idaho. Behind these larches, a diversion of a few yards takes you to the old, narrow avenue of Scots pines which stood here before the Pinetum was established.

Deep valley Back to the larches, coming out on Hills Avenue you pass two small young specimens of the odd looking Chinese golden larch. Keeping to the same side of Hills Avenue and returning down the bank towards the deep valley, you will notice in passing a group of Asiatic silver firs, of a rather mixed standard of growth. The long valley across the road is Cypress Valley (**5**), where there is an old grand fir 47m (155ft) tall, several large Leyland cypresses, and then a group of the rare American white cedar.

After looking at the dwarf conifer collection inside the fence, walk up on to Yew Bank where several forms of common yew show their bright colours. On the lower slope is the Visitor Centre (**6**), well stocked with books, leaflets and posters. Continuing beyond the Centre you come to North

Birds at Bedgebury

The mixture of trees, tall shrubs, mown rides and uncut grass provides an excellent habitat for birds. The dense crowns of cypresses are favourite places for roosting and nesting and are used by greenfinches, chaffinches, lesser redpolls and goldcrests. In winter the largest known roost of the hawfinch occurs in Cypress Valley: up to 100 birds may be present. In the years of crossbill invasions, and for some years afterwards, numbers of crossbills feed on the cones of larches, pines, Douglas fir and spruces. Firecrests have bred in recent years, and siskins breed almost every year. Treecreepers are also commonly seen on the bark of tree boles.

Avenue, a broad ride planted in 1935 with grand fir and a solitary ginkgo, with leathery fan-shaped leaves that fall in autumn.

Towards Pine Hill Across this ride at the upper end is a planting of rare broadleaved trees, hickories, and a trident maple; while across the ditch is a Prince Albert's yew from Chile, and beside a narrow path through the rhodendrons a group of rare, tender conifers from New Zealand and Chile. The path leads out to a large group of pines and, on the edge of Hills Avenue, you come to more pines – rugged bishop pine and Monterey pine. Across the Avenue, Pine Hill (7) has Leyland cypresses dotted among 5-needle pines, and to the right a woodland displaying the 2-needle black pines – Austrian, Corsican and Crimean.

More cypresses Going down the other side of Pine Hill, a narrow path leads to the left of the black pines. A commanding view opens out before you of Cypress Valley, displaying the dozens of forms and varied colours of the Lawson cypress. This is the tree which, in the course of raising seed at British and Dutch nurseries, has yielded a great panoply of forms, with every different type of foliage a cypress can grow.

Descend into Cypress valley, planted in 1925, and cross the bridge and turn right to come to an opening on to the road. Cross the

Above: Hill's Avenue across Cypress Valley, with forms of Nootka cypress.

Below: Wissel cypress in spring, one of the many Lawson cypresses that grow in the valley.

Left: The pine looper caterpillar, demonstrating the walk that gave it its name. Its white-striped green body resembles the needles of Scots pine on which it feeds, and the reddish brown head matches the colour of the twig. It is seen from May to July, and its adult form, the pine beauty moth, flies in spring until May.

Right: A lesser redpoll shows its crimson forehead while feeding the young. The nest is in a typical situation, protected by the radiating branches of a silver fir.

road and bear left up the bank among many forms of the variable Japanese Hinoki and Sawara cypresses, then pass among the thujas. The foliage of the small Korean thuja is often a silvery blue colour, with a snow-white underside. If you crush a small piece in your fingers, it yields a scent of fruit-cake.

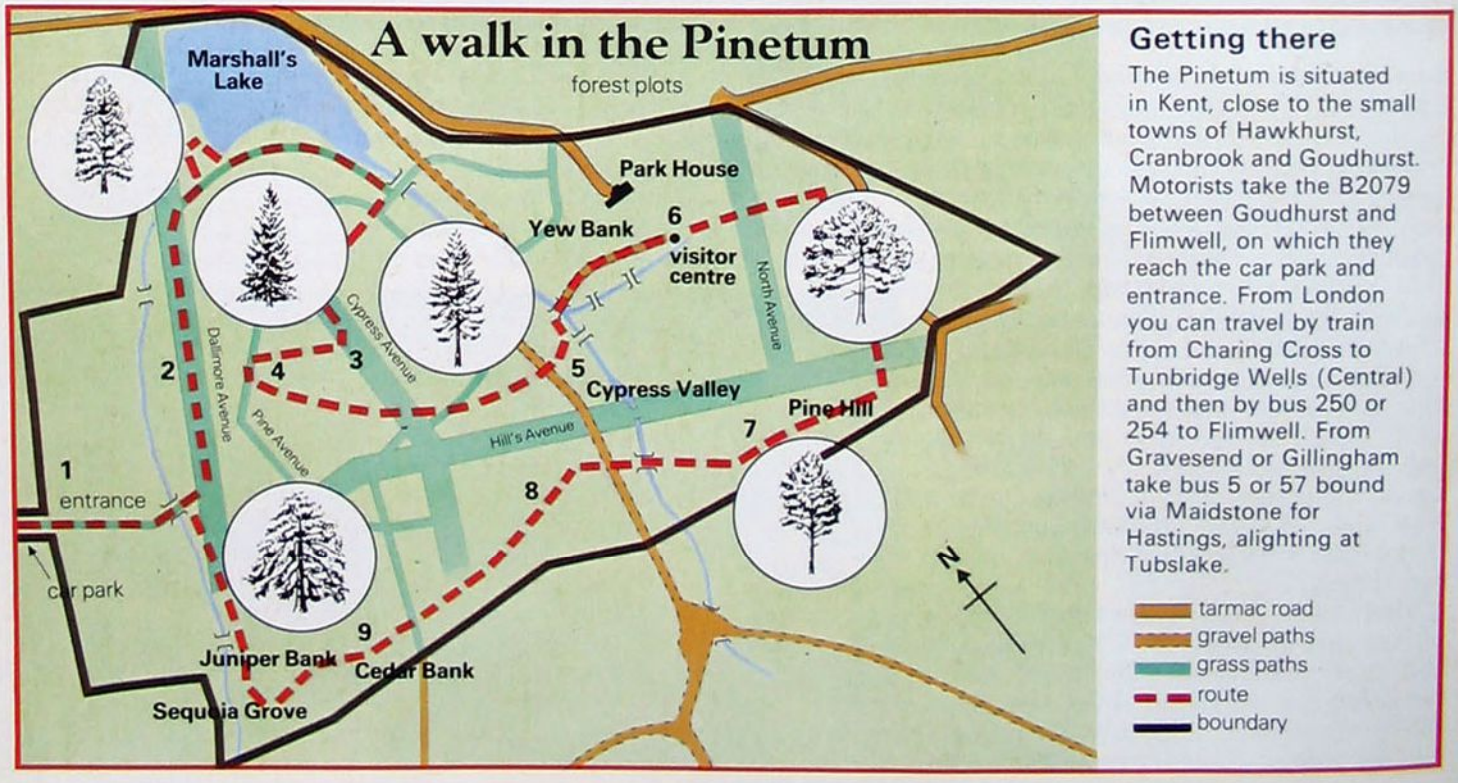
On Cedar Bank Leaving the valley you come to some garden forms of the Japanese red cedar (*Cryptomeria*), then the wild forest form of the same tree, its superb boles covered with orange-brown bark. Then, passing a group of Chinese firs (*Cunninghamia*) on the right, the path leads out onto the open top of Cedar Bank (**9**). Here you will see all the four species of true cedar: from Cyprus, a rare tree; from Lebanon; the deodar, from the Himalayas; and Atlas cedar, in a splendid example of the blue form.

A little further on is Juniper Bank, which is the world's most complete set of junipers to be found in one spot. Further down the slope are the sequoias, and to the left a beautiful grove of coast redwoods. This species produces the world's tallest trees but is not well enough suited to the British climate to reach its most impressive heights.

The grove was planted in 1925 and the trees are around 27·5m (90ft) tall.

Across the stream are the giant sequoias, also planted in 1925. The biggest has a bole 5·2m (17ft 2in) round and is 29m (95ft) tall. While this has the distinction of being the heaviest tree in the Pinetum, the tallest is an older giant sequoia standing by the footbridge near the lake, 37m (121ft) high.

Follow the stream back to Dallimore Avenue, noticing as you pass a group of Likiang spruces, to return to the starting point.



Getting there

The Pinetum is situated in Kent, close to the small towns of Hawkhurst, Cranbrook and Goudhurst. Motorists take the B2079 between Goudhurst and Flimwell, on which they reach the car park and entrance. From London you can travel by train from Charing Cross to Tunbridge Wells (Central) and then by bus 250 or 254 to Flimwell. From Gravesend or Gillingham take bus 5 or 57 bound via Maidstone for Hastings, alighting at Tubslake.

GRACEFUL LADY OF THE WOODS

Few trees match the style of the birch. The narrow trunk, silvery bark and slender branches ending in a mass of drooping twigs have the outline of a fountain that produces a cascade of delicate leaves. No wonder it has become known as the Lady of the Woods.

There are three native species of birch in the British Isles but only two, the silver birch and the downy birch, are common. They thrive particularly well on acid soils, but rarely grow on chalk. The silver birch grows best on dry sandy or gravelly soils such as those of the heathlands of southern England, but the downy birch prefers wetter soils and a cooler climate and so is most common in the uplands of Scotland, Wales and Ireland. However, their ranges overlap considerably and they are often found growing in the same areas, exploiting local variations in the wetness or drainage of the soil.

Differences in detail In general form the silver and downy birch are very similar and can be described together, although they differ in a number of details.

The silver birch, as its name suggests, has much whiter bark, whereas the bark of the downy birch is more variable, ranging from silver-grey to brownish in colour. The only way to distinguish the two species from a distance is by the colour of the bark. A characteristic of old silver birches is the patches of rough, knobbly black bark replacing the white bark at the base of the trunk. In downy birches the bark remains more or less smooth right down to the ground.

Secondly, unlike downy birches, silver birches typically have hanging or 'weeping' twigs–a feature that has been exaggerated by selective breeding to produce ornamental

Birch woodland in early autumn with young oak and sycamore, and a ground-covering of bracken.

varieties that grace many parks and gardens. And the twigs of the silver birch are smooth, whereas those of the downy birch are covered with short fine hairs.

Leaves, flowers and fruits The foliage appears towards the end of April, the leaves unfolding from small, pointed buds that are arranged alternately along the thin, purplish-brown twigs. The bright green leaves, about 3cm (1in) long, are usually triangular in outline but the shape may vary from diamond to oval. Their margins are rather unevenly toothed and they taper to a sharp point. They are borne on slender stalks which allow them to twist and flutter in the breeze. The leaves of young birches are often much larger than those on full grown trees because they grow much more vigorously. After a heavy shower in late spring the air in a dense stand of birch has a delicate fragrance from the aromatic resin washed from the unfurling leaves and from tiny warts on the twigs.

In autumn the leaves turn bright yellow, before falling in October to leave the trees bare, but still beautiful, their trunks gleaming white in the pale wintry sunlight.

Birch flowers are catkins and both sexes are borne on the same tree. The males develop during autumn and by April or May have turned into a dangling catkin about 5cm (2in) long, covered with reddish brown scales which separate to release their pollen. The female catkins appear with the unfolding leaves. They are held erect on the twigs, 2-3cm (1in) long, and are made up of overlapping green scales, each shielding an ovary from which two purple stigmas protrude to catch pollen grains wafted on the wind.

Above: **Silver birch** (*Betula pendula*). Deciduous, native, grows to 25m (80ft) throughout the British Isles, on light soils, heathland, may form pure woods in the Scottish Highlands. Rare on chalk. Flowers April, fruits July.

Above right and below: **Downy birch** (*Betula pubescens*). Deciduous, native, grows to 20m (65ft) in similar areas to the silver birch though it prefers wetter, colder conditions.

After fertilisation the female catkins expand into club-shaped cone-like structures that slowly disintegrate in autumn to release the tiny winged fruits. These are so light they may be carried for considerable distances by strong winds.

Birch woods are a favourite haunt of redpolls and siskins, winter visitors from Scandinavia, which feed on the seeds scattered on the ground.

Hardy pioneer The birch is an extremely hardy tree and has established itself in some northern-most forests at the frontier of the treeless tundra. The pollen record shows that birches and pines were the first trees to advance into the British Isles when the climate warmed after the last Ice Age. Both species formed vast forests but were confined to the better-drained uplands.

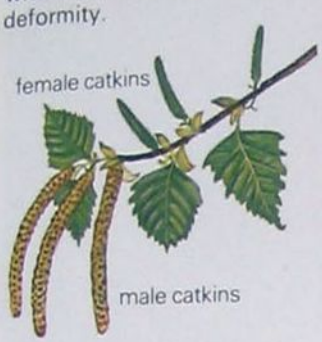
Today the birch is found in most woodlands on the poorer soils, from English oak woods to Scottish pine woods. It also forms pure birch woods–you can see good examples on the sandy heaths of southern England and the steep hillsides of Scotland.

The birch is an aggressive colonizer of forest clearings, ungrazed heaths, and areas which have suffered recent burning. Its tiny winged seeds spread in profusion and germinate quickly to invade new areas. The pioneer trees form dense thickets of fast growing saplings that develop into pure birch stands up to 25m (80ft) tall at maturity.

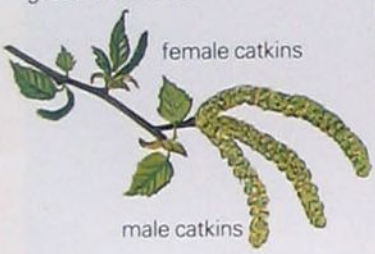
Fungi associates Birch trees have a remarkable relationship with the fly agaric fungus which sends up its striking red toadstools in autumn. The fungus is attached to the tree's roots and both benefit from this association: the fungus speeds the entry of soil nutrients into the root system of the tree in return for sugars manufactured by the tree.

You may also find the bracket fungus clamped on to the trunks of older trees. It is a parasite, feeding on the tree's sap but giving nothing in return. Indeed, this fungal

Right: Not birds' nests among the branches of a mature silver birch, but witches broom, a growth deformity.



The ripe seeds in the fruiting catkins have large wings – 2-3 times as wide as the seed in the silver birch (above) and 1-1½ times in the downy birch (below), allowing them to spread to great distances.



Below: A large gall growing on the trunk of a silver birch may damage but is unlikely to kill the tree.

Below right: The small bracket fungus (*Trametes versicolor*) thriving on a dead birch tree. The fungus may continue to feed on the rotting wood for many years.

assault so weakens the tree that it soon perishes, and the fungus continues to feed on the dead wood. Although the birches' death is often hastened by fungal attack, birches do not live for a long time anyway – rarely exceeding 80 years. Dead or dying trees are favourite nesting sites for woodpeckers whose bills can easily tunnel holes into the wood softened by decay.

Witches broom Many birch trees appear to have large birds' nests among their branches. In fact these untidy tangles of twigs are galls, a growth deformity caused when the buds are attacked by either a fungus or a tiny mite. A dense mass of twigs sprouts at the point of attack to form the so-called witches broom. (Actually birch twigs are cut and bundled to make the sort of broom that witches are supposed to fly around on at night. They are also used for steeple-chase fences to fill out the jumps.)

Bark and timber The thin paper-like bark is shed in strips as the tree grows, and is replaced anew from underneath. Birch bark is remarkably resistant to decay – the bark on a fallen log remains for months after the wood inside has rotted to a soft pulp. It is also waterproof, and has been used in parts of Europe for roofing. Birch bark makes excellent kindling for camp fires and the wood itself burns very well. In parts of Scandinavia and Central Europe birch wood is still the main winter fuel.

Birch timber is a pale creamy brown colour and has been put to a wide variety of uses: for instance, the making of carts and packing cases, and smaller items such as floor tiles, cotton reels, spools and bobbins for the textile trade. But although it is a hard wood, it does not last long out of doors.

In spring there is a copious flow of sugary sap through the trunk and in some country districts this is collected by tapping the trees; the liquid is fermented into wine.

Dwarf birch There is a third species, the dwarf birch (*Betula nana*), an arctic-alpine shrub less than 1m (3ft) tall which grows at a few sites in the Scottish Highlands. It also has the distinction of being the only woody species to grow in the frozen wastes of Greenland – the world's northern limit for woody plants. Here it takes the form of a low wiry bush, spreading close to the ground, its growth stunted by the icy blasts of Arctic gales. Its leaves are smaller and rounder in shape than those of the other two species. A few specimens occur in Northumberland, but it is generally a rare species.

FOREIGN FISHES

Some of the most familiar fish in our waters, such as the carp, are not native, but were introduced centuries ago. Not so the tropical species that make a surprising appearance – they are abandoned pet fish.

Man is often responsible for carrying animals and plants with him as he moves around the world. In many cases this is accidental – plants are carried in ships' ballast, and stray seeds in grain or in animal fodder. In other cases it is deliberate – the introduction of the grey squirrel to Britain is a well-known example. Many of the best-known instances involve animals introduced to islands which, because of their generally sparse fauna, provide ideal opportunities for the exotic animal to thrive.

This is illustrated by the freshwater fishes introduced to the British Isles. Compared with the mainland of Europe we have relatively few native freshwater fishes – at most 33 species, as against about 145 in Europe. As a result, some introduced species have thrived particularly well.

Common carp Some of the non-native species were introduced so long ago that they are now rarely thought of as 'foreign fish'. The carp is a typical example. No one knows for certain when it was introduced to the British Isles (it is native to the Danube and eastwards, including Greece), but it has been here so long most people regard it as one of our native fish. It was first mentioned in print as a British fish around 1496, but it was not common then. Archaeologists have found other evidence in the form of carp bones in Tudor remains in the south of

Above: Stocking a river with trout fry from a hatchery, which takes place in spring. Later in the year slightly larger fish, known as fingerlings, are used. Large numbers of these fish die in their new homes before reaching maturity.

Below: Rainbow trout in a hatchery, where they are bred to be used as stock for anglers in hundreds of lakes and rivers. There are only six established breeding colonies of rainbow trout in the 'wild'.

England, but nothing so far in earlier sites.

Today, the carp is widely distributed in Britain, but it frequently owes its presence to anglers who have stocked lakes with it. The related crucian carp is certainly a native fish, although it is often claimed as an introduction, largely as a result of some authors calling it the 'Prussian' carp. Its bones have been identified in Roman archaeological sites in London.

Rainbow trout Two members of the salmon family–the rainbow trout and the brook charr–are more recently introduced fishes. The rainbow trout was first introduced to England in 1884. Its original range is the coastal drainage area of the Pacific coast of North America from Alaska virtually to Mexico, and several rainbow trout hatcheries were established along this coastline. The rainbow trout has been distributed to many parts of the world from these hatcheries, although ironically several of the original populations in its native range have become extinct.

Brook charr originally came from eastern North America, roughly from Quebec to South Carolina, and this species has also been widely re-distributed. It was first introduced to Britain in 1869 and many subsequent introductions were made, a number of these resulting in established breeding populations. In the last ten years in Britain, some fish hatcheries have raised large numbers of brook charr, mainly for angling lakes, and the species is becoming much more familiar in British lakes and rivers.

Above: The rainbow trout (*Salmo gairdneri*) can be distinguished from the native brown trout by the coloured band on its side and its spotted body.

Weighty wels Most of the introduced fishes in Britain have proved to be rather slow to establish themselves and have not spread, or have only done so with the help of man. One example is the European catfish known as the wels–a rather unattractive looking fish with several long barbels around its mouth. It is native to the Danube and eastwards, where it grows to a huge size, reportedly 5m (16ft), with a weight of 306kg (675lb). Its introduction to various places in the British Isles during the last century was usually accompanied by controversy over the

Below: The pumpkinseed (*Lepomis gibbosus*), pictured here with rudd, is a North American cold water fish. There are two populations in Britain, in Somerset and Sussex, which were probably established when pet aquarium fish were released into the ponds.

Introduced fish facts

Above: The zander (*Stizostedion lucioperca*), known as a pike-perch although only related to the perch, reaches an average length of 45cm (18in) with a weight of 1kg (2lb).

Above: The wels (*Silurus glanis*) is a member of the catfish family. It has a slimy, scaleless skin and measures on average 100cm (39in), with a weight of 10kg (22lb).

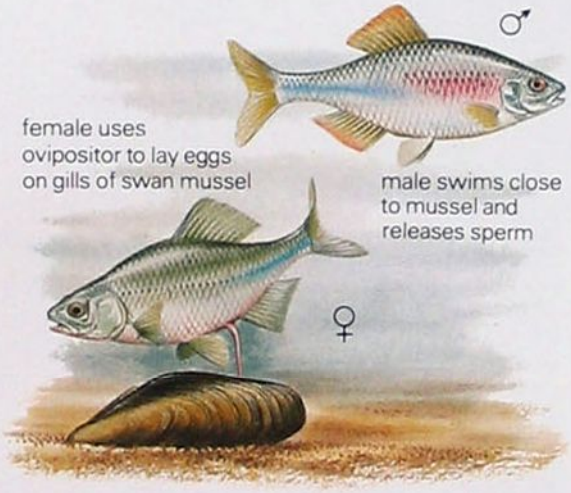
Above: The brook charr (*Salvelinus fontinalis*), also known as the brook trout, shown here in breeding colours. It reaches 65cm (25½in) in length, 3kg (6½lb) in weight.

wisdom of releasing such a large fish in British waters. Eventually, the only populations to become established were those in the lakes at Woburn Abbey (some of these were later released into neighbouring Bedfordshire and Buckinghamshire lakes), and the reservoirs at Tring in Hertfordshire. The largest specimen caught by an angler in Britain was taken from Tring in 1970; it weighed 19·7kg (43lb 8oz).

Tropical guppies Much less impressive in terms of size, but considerably more attractively coloured, were two populations of guppies which survived for several years, one in the River Lee at Hackney, London and the other in the St Helen's canal in Lancashire. Both were living in warm water discharges–the former from a power station and the latter from a glassworks. With the closure of the power station and the presence of predators, the River Lee's guppies disappeared, but the St Helen's canal fish continued to thrive. This canal is also the habitat of several other tropical fish species, which are often caught by anglers. They all came from a local pet shop which, when it closed, released its stock into the canal.

Above: Colourful guppies (*Lebistes*), more familiar as aquarium fish, have established populations in freshwater. The release of former pet fish is now illegal, but has led to the presence of goldfish in numerous lakes and rivers.

Right: The bitterling (*Rhodeus amarus*), a rare introduced fish, has a fascinating method of reproduction, involving a third party, the swan mussel, as a host for the eggs. When they hatch after 2-3 weeks, the young swim away.



Below: The Chinese grass carp (*Ctenopharyngodon idella*) has recently been experimentally introduced as a possible solution to the problem of clearing weed-choked ponds.

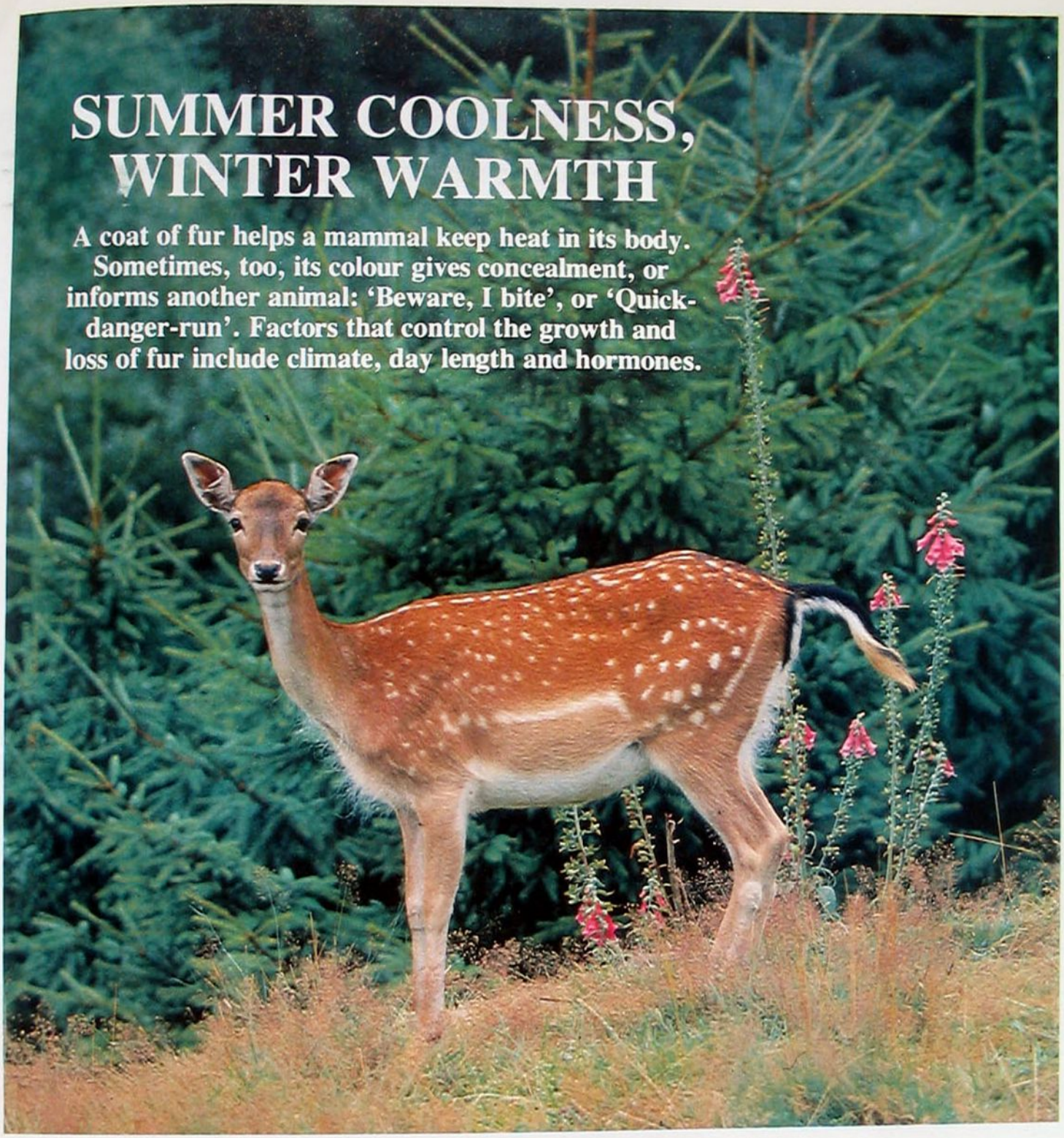
The spread of the zander Such fishes have fitted easily into their new environment and caused few problems. The same cannot be said of the zander, a European relative of the perch, but a much larger fish, which was released in the early 1960s into the Great Ouse Relief Channel. Curiously, zander have lived in the lakes at Woburn Abbey since the 1870s without causing great problems, but once they were released into the river system of the Great Ouse, they began to increase their numbers and range greatly. Throughout the 1960s and 1970s the zander spread through the Great Ouse system, and by the late 1970s they began to turn up in other river systems elsewhere in the country.

Their success in establishing themselves is due to a number of factors, one of which is that they are particularly well adapted to life in the slow-flowing, sparsely vegetated, rather murky waters that comprise so many of our lowland rivers. They are also efficient predators, finding the large numbers of rather small cyprinid fishes (members of the carp family–bleak, roach and dace especially), living in such waters easy prey. As a result, they are extremely abundant in many of the waterways to which they have found their way. The spread of the zander has been partly natural, because most of the rivers of East Anglia are interconnected, but it has also been aided by anglers who have taken fish from one water and released them illegally in another.

Predatory problems The spread of the zander has meant that the numerous cyprinid fishes which made up so much of the catch of anglers have become scarce. The other predators native to these waters, perch and pike, are now fewer and smaller. The addition of a third, and possibly better adapted, predator in the form of the zander has affected both competing predators and prey and has caused considerable changes in the fish life of these rivers. Unfortunately, the zander cannot now be controlled and there is little doubt that it will spread in the next decade or two to the whole of lowland Britain.

SUMMER COOLNESS, WINTER WARMTH

A coat of fur helps a mammal keep heat in its body. Sometimes, too, its colour gives concealment, or informs another animal: 'Beware, I bite', or 'Quick-danger-run'. Factors that control the growth and loss of fur include climate, day length and hormones.



One of the things that identifies a mammal is its body covering of hair or fur. A mammal is warm-blooded and is able to control its own body temperature at more or less the same level, even if the temperature around it is much higher or lower. The furred mammal can live in the heat of a hot summer or the snowy blizzards of a harsh winter. However, it must be able to store heat when its surroundings become too cold, or get rid of heat when its body is too hot.

The mammal's fur acts as a good insulator, in cold weather stopping too much heat from leaving the body, and thereby keeping the mammal warm. Even when the weather becomes very hot, fur – acting as an insulator – prevents too much heat from entering the body. But once the heat has entered the body of a mammal, the animal finds it difficult to get rid of any excess. However, many mammals are able to cope with the excess by pushing out water – in the form of sweat. The sweat evaporates on the body surface and in doing so cools the mammal.

The base of a hair is well supplied with nerves. This allows the hair to transmit messages via the nerves to the brain when it is touched. Whiskers (vibrissae) are specially modified hairs used as sensory organs.

Changing coats Another way mammals prevent their bodies becoming overheated or too cold is by changing the thickness of their

Above: Springtime spots. The common fallow deer is a uniform greyish brown in the winter, but as spring progresses this coat is lost and replaced by an attractive white-spotted summer coat. The spotted coat matches the dappling of sunshine and shadows that are cast through the leaves of the woodlands where the deer spends much of its time. As long as the mammal does not move, it blends into its surroundings and does not attract any predator.

Above: Run-rabbit-run. A rabbit, on detecting any danger, dashes for safety. It raises its tail and the white 'flash' so exposed tells all other rabbits of the impending danger.

fur with different seasons. They grow dense fur in winter that traps warm air, and thin fur in summer through which the air circulates easily. The roe deer, for example, has a winter coat that is twice as good at keeping the heat in the body as the summer coat.

A thin summer coat also helps in the evaporation of sweat in those larger mammals, such as red deer and horses, that use sweating as a cooling device. Small mammals, such as mice and shrews, do not have sweat glands over the general body surface. If they did they would lose water (dehydrate) quickly and probably die.

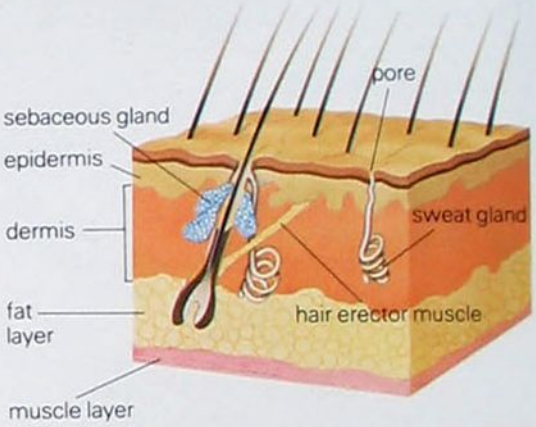
Concealment and display A furry covering can be coloured for camouflage. For example, the dappled summer coat of the fallow deer provides effective concealment among the trees in summer, and the Scottish mountain hare moults its brown summer fur for a white winter coat that provides excellent camouflage against a snowy background.

The colour of fur is also important in display and warning behaviour. The white underside of the tail in rabbits and roe deer is for warning. A rabbit's tail is raised when it detects danger and dashes away to safety. Fellow rabbits recognise the white 'flash' as a danger signal and also run for cover or to safety down the rabbit warren.

Hair growth A hair develops from a hair follicle (see diagram opposite), which is an inpushing of the outer surface of the skin epidermis. In most mammals the coat consists of coarse overhairs, called guard hairs, waterproofed by oily secretions from special glands – the sebaceous glands. Beneath the outer layer lies the fine underfur, or wool, that traps warm air at the skin's surface. The insulating power of animal fur depends on the amount of air (a poor conductor of heat), that is trapped within the coat.

The change in coat colour from one season to another is possible because the growth and replacement of hair occur in cycles that can be geared to any change in the animal's surroundings. Throughout the life of a mammal the hair follicles have periods of activity when new hairs are produced, and periods of rest when the hairs are either moulted or kept. In an active hair follicle, cells divide at the base and stream upwards. They lengthen and become filled with a tough fibrous protein, called keratin, which forms the hair. During its growth pigment of various colours passes into the hair from pigment cells at the base of the follicle. The new hair emerges from the skin alongside the old hair.

Beneath the skin surface



Then the hair follicle rests for a time with the hair firmly anchored by a club-shaped base. While the new hair is growing, or after the second hair has emerged, the old hair is either shed or retained.

Several factors including climate, hormones and daylight length, determine when the hairs grow, how many hairs are produced, the length and thickness of the hair grown and whether the old hairs are shed or kept so that the density of the coat is altered.

Seasonal coats In some mammals a seasonal coat change is achieved by one moult a year. The fox, for example, sheds its heavy winter coat in spring and grows a new coat gradually through the summer and autumn. Certain other mammals change their coat twice a year, in spring and autumn, resulting in summer and winter coats with very different characteristics. For instance, in the field vole, more hair follicles become active at the autumn moult and fewer old hairs are lost than in spring. This results in the vole having a dense winter coat of fur. The increase in the number of hairs in winter is due mainly to the fine underfur being kept. Also, all the hairs grown in autumn are finer than those grown in spring. The dense, fine winter coat acts as a good insulator, whereas in the summer air circulates easily through the coarser, thinner coat. Similar coat changes occur in many other small mammals such as the field mouse, the shrew and the mink.

In the mountain hare the white winter coat is twice the length and twice the thickness of the summer coat. However, an increase in length of the fur is not always a good adaptation to winter conditions. Some ponies have long thin silky coats and are therefore unable to survive cold and snow. The hardy Exmoor pony, on the other hand, copes well with severe winters by growing a dense winter coat of underfur beneath the wiry guard hairs of the top coat. This coat is such a good insulator that snow does not melt immediately on the Exmoor's back, building up to create a curious 'snowpony'.

Red deer have guard hairs that are somewhat shorter in summer and little underfur is evident. The structure of deer hair is different from that of most other mammals in that it contains large air spaces. In the roe deer, the air spaces inside the guard hairs are much larger in winter than in summer. This means that because of their increased thickness, the wide winter hairs are packed closely together, and so give very good insulation. Also the roe deer shows a seasonal colour change of coat, from a dull brown winter coat to a bright russet glossy summer coat. Such a colour change is certainly not for hiding purposes, but it may aid the reflection of sunlight from the body. Also it may relate to breeding.

Changing daylength Increasing daylength leads to the growth of a summer type coat, whereas decrease in daylength encourages the change to a winter coat. By artificially altering the length of day, mammals can be induced to grow a coat which is out of line with the seasons. In an experiment researchers exposed red deer stags to a 'two years in one' daylength. Here the daylengths were artificially lengthened and shortened so one year was covered in 6 months. Under these conditions the deer changed their coats and grew and shed their antlers twice in each calendar year.

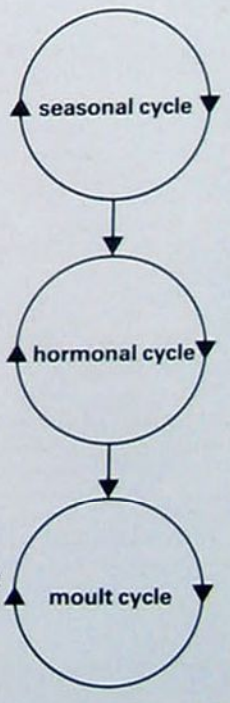
Influence of temperature In the wild temperature also plays a role in the seasonal coat changes. In the Scottish mountain hare, although daylength is an important factor influencing the moult, the change from winter whiteness to a brown coat is faster in a warm spring. The change to winter whiteness happens faster in a cold winter. Also the hare turns white earlier and more completely at high altitudes, and this is related to the extent of snow cover. As well as being useful as camouflage, it has been suggested that a white coat may reduce the radiation of heat from the body.

Above: Seven-day old voles beginning to grow their fur. Only mammals possess true hair—an important distinction between them and all other living things. The fur forms an insulating covering that helps the animal to retain its body heat.

Opposite below: The coat of an otter is waterproof due to an oily secretion given out from sebaceous glands in the skin. The long, sensitive whiskers—the vibrissae—are made up of specialised hairs.

Cycles of change

A stoat can exchange its summer coat of brown for one of winter white. This change is far more complex than it appears. Stoats that live in mild-wintered climates change their coats in spring and autumn but the fur stays the same brown shade. It is evident that in mammals the moulting cycle, breeding cycle and hormone cycle are enmeshed like the cog wheels in a clock. Temperature and the daylight length in the environment in which the mammal lives drives the hormone cycle that controls the moult cycle. Hormones also cause the different coloured pigments to be laid down in hairs in various seasons.



HIDE AND SEEK MOTHS

The noctuids are one of the biggest families of moths – over 300 species breed in Britain! They are fast-flying, fat-bodied moths, active only at night when they sometimes come to lighted open windows.

By day noctuid moths hide away among leaves or on tree trunks, and nearly all are dull shades of grey and brown – excellent colours for camouflage. A few species, however, have bright red wing markings; all the species marked in this way are out and about as adults during the autumn months. Most of the red moths in other families (the burnets and tigers, for example) make themselves obvious by day and their bright colours warn birds to avoid them because they are poisonous. The red noctuids, on the other hand, are not poisonous and use their red colour for protection in other ways.

The red underwing moth (*Catocala nupta*) is the best known of all the red noctuids. It has a wingspan of up to 8cm (3in), which makes it the biggest British moth in the family. The adult hatches from its chrysalis in August and lives on well into the autumn – usually until late October. It uses its long tongue to feed on nectar from late-blooming flowers, and also on the sweet sap that runs from the damaged trunks of trees.

During the day the red underwing hides its 'red petticoats' completely as it rests on a tree trunk. The delicately patterned forewings camouflage the moth perfectly. If a bird should happen to peck at a resting red underwing, the moth flicks its forewings forwards and flashes its brightly coloured hindwings in the face of the attacker. This is a distraction display; it often scares the bird away and saves the moth's life.

The female red underwing lays her purple-brown eggs, a few at a time, in crevices in the bark of poplar and willow trees. The egg stage lasts right through the winter, the caterpillars hatching the following April.

Throughout its life – from April to July – the caterpillar spends the day hidden in a crevice on a tree trunk, climbing up the trunk at night to feed on the leaves. The caterpillars are long and thin, and in colouring match the tree bark exactly. The fully grown caterpillar usually spins a few dead leaves together with silk, and pupates inside. The brown pupa has a coating of bluish-white powder. The adults emerge in August.

The red underwing is fairly common in the south and east of England, but becomes rarer in the north. Two of the red underwing's close relatives are much rarer. Both the dark crimson underwing (*Catocala sponsa*) and the light crimson underwing (*C. promissa*) have a similar life cycle to that of the red underwing, except that their caterpillars feed on oak leaves, not poplar and willow. Both species are hardly ever found anywhere in Britain except in and around the New Forest.

The herald moth is common, and more widespread than the red underwing, and can be found anywhere on the mainland of Britain and Ireland. Unlike the red underwing, the herald's red colour is on its forewings and is therefore always on view, even when the moth is trying to hide. The herald's shape makes it resemble a dead, shrivelled leaf, and the red colour, combined with the duller colours, helps to improve its disguise.

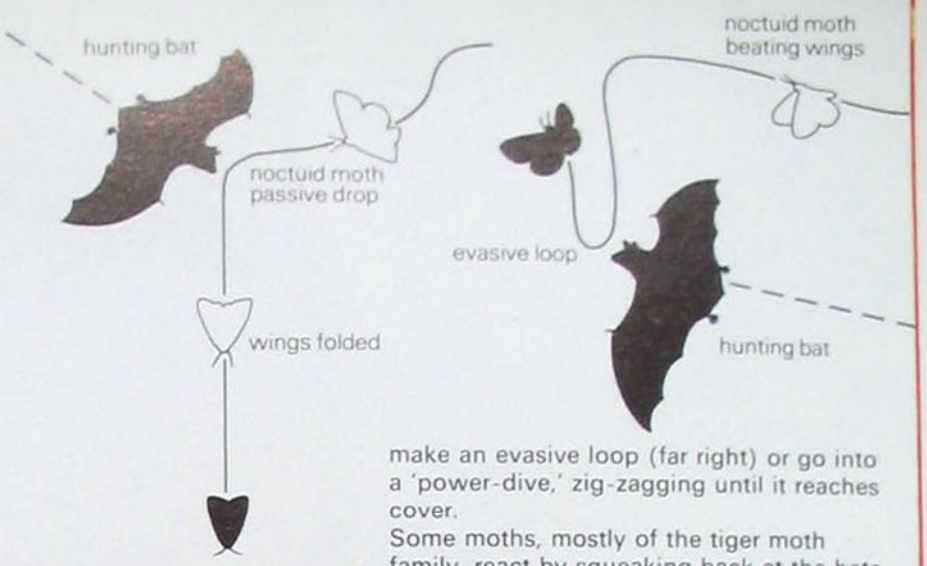
The herald moth is one of a small group of noctuids that spend the winter in the adult moth stage. In late autumn the herald flies around ivy blossoms, feeding on one of the

A herald moth (*Scoliopteryx libatrix*) on a sallow twig. This species has a wingspan of 4cm (1⅝in). The antennae of the female are threadlike and not feathery like those of the male. Like the red underwing moth, the herald flies at night. If it is disturbed, this moth quickly falls to the ground. If you want to see the herald (and other moths) at close quarters, you can attract them by 'sugaring' tree trunks. Make up a mixture of sugar, treacle and rum and smear it on a suitable tree trunk in a place that is easily visible. The sweet mixture will attract the moths from twilight onwards.

Sound tactics

Many moths—including all the noctuids—have sensitive ears on the sides of their third (hindmost) thoracic segment, just below where the hindwings join the body. The ears are often hidden under the furry body scales, and the ear drum itself is set in a pit. Sounds make the drum membrane vibrate and this triggers the nerve impulses which reach the moth's brain and enable it to hear. The nerve impulses fire most strongly when very high-pitched sounds are heard. So the sounds that moths are best at hearing are those made by the moths' most dangerous night-time enemy: bats.

Bats hunt moths at night and they find their prey by making ultrasonic squeaks and listening for the echo as the sound bounces back from a flying moth. Noctuids are among the favourite prey of the larger British bats, but they have several ways of evading capture. When a noctuid hears a bat's sonar squeak it may just close its wings and drop to the ground (right), or



make an evasive loop (far right) or go into a 'power-dive,' zig-zagging until it reaches cover.

Some moths, mostly of the tiger moth family, react by squeaking back at the bats. This may possibly jam the bat's sonar, or it may warn the bat that the moth is poisonous—fulfilling the same function as the moth's warning coloration.

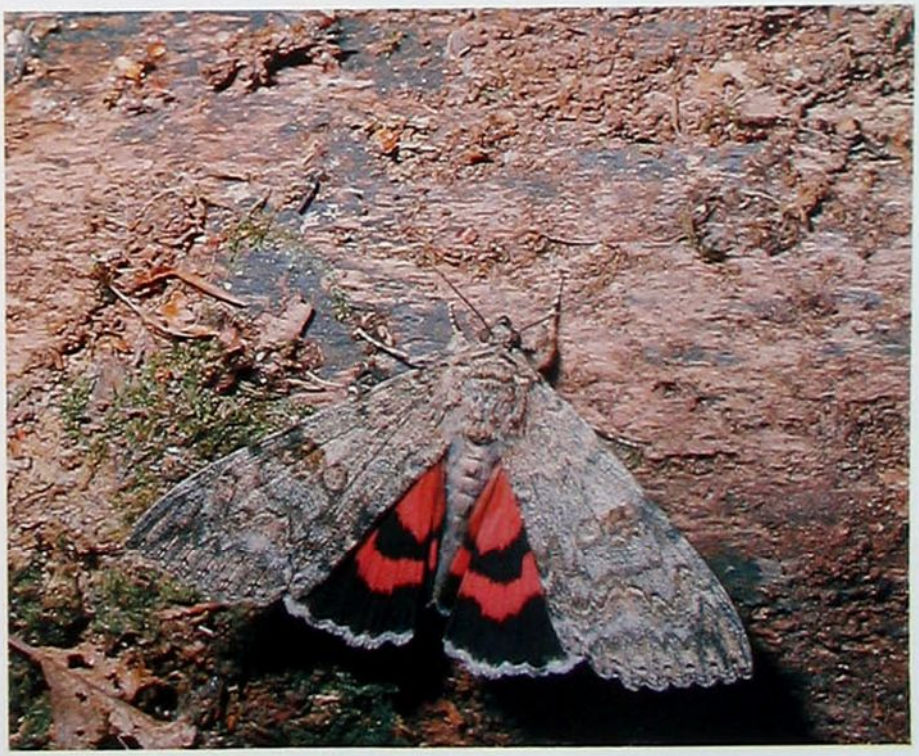
The red underwing moth resting with its wings closed (right) is perfectly camouflaged against bark. When disturbed it opens its wings (above) to flash its red underwings in a 'distraction' display.

Left: The greeny-grey red underwing caterpillar is very difficult to see as it rests during the day on a willow twig. At night it climbs up the twig to feed on the willow leaves.

Below: A red underwing showing its red 'petticoats'. The colour of its underwings make it one of the most handsome of all the noctuids in the British Isles.

last sources of nectar before winter sets in. It then finds somewhere sheltered to hibernate – in a roof loft, a shed or barn, inside a church, or perhaps a cave. When it hibernates in a humid cave, the moth often becomes coated with dew, but this seems to do it no harm. The furry scales on the wings probably prevent the water from penetrating.

In early spring the herald wakes up and searches for a drink from one of the earliest sources of nectar: pussy willow catkins. The female lays her eggs on willow, sallow and poplar trees, taking the opportunity to feed on nectar from the catkins produced by all these trees. The herald caterpillars feed on the same sorts of leaves as the red underwing caterpillars—but since they spend all their lives among the leaves, are camouflaged green instead of a tree bark colour. The herald moth caterpillars feed from May to August, then change into black pupae enclosed in white cocoons. The adults begin emerging in August and are on the wing until October, after which they hibernate until the following spring.



BUZZARDS: RUGGED BIRDS OF PREY

Buzzards, usually seen wheeling and soaring, gained an early reputation for laziness, although patient waiting is part of their efficient hunting strategy. They are not agile, relying mainly on a silent planing approach to catch their varied prey.

Three buzzards occur regularly in Britain, the common buzzard, the much scarcer rough-legged buzzard and the unrelated, but equally scarce, honey buzzard which is a similar sized bird to the other two but belongs to an entirely separate family.

The common buzzard (pictured left) is a familiar bird of prey in Wales, south-west England, the Lake District and Scotland, although it is absent from much of lowland England. It is the British bird which, perhaps, comes nearest to the familiar conception of what a bird of prey really looks like. One of the most obliging features, for the bird watcher, is that this bird is so conspicuous. Perched, it has a slightly hunched attitude, and its compact, robust features are clear; in flight, its broad wings, short tail and soaring habit, often with wings rigid and upturned, immediately proclaim it as a bird of prey. In sunny weather it spends much time in the air, wheeling and circling above woodland or open hillside, often calling loudly with a plaintive and characteristic mewing.

Although it is predominantly a brown plumaged bird, relieved only by the bright yellow of its feet, legs and cere (the fleshy covering at the base of the bill), individuals are very variable. The wings can be the whole range of colours from blackish brown through all shades of blotching and streaking to almost white in some birds.

In population terms the buzzard qualifies as a successful bird in the British Isles. There are 20-30,000 individuals, although they are by no means universally distributed. In upland areas where the buzzard is now concentrated numbers may be prodigious. Although buzzards are numerous in the south-west, slightly less so in the Lakes and Scotland, they are nowhere more numerous than in Wales. Here on a sunny day in April you may see up to 100 individuals in a day's travelling, with pairs breeding at intervals of half a mile or so. The densest buzzard population yet recorded was on Skomer Island where up to eight pairs have been noted on the 722 acres.

Diversity of habitat appears to be the key to the buzzard's success. Over extensive areas of

Right: **Rough-legged buzzard** (*Buteo lagopus*), 55cm (22in) from beak to tail. Breeds in Scandinavia where it is at the mercy of fluctuating populations of small mammals for food.

Left: **Honey buzzard** (*Pernis apivorus*), 58cm (23in) from beak to tail. Rare summer visitor in the extreme south. (Common buzzard also shown for plumage comparison).

Below: Some buzzards nest in crags or cliffs; pairs move to a new site annually.

mountain, moorland or forest numbers are relatively low, but in valleys where broken countryside is studded with trees and copses, old hedgerows and small fields, breeding pairs can be numerous. Here the variety of countryside and rough vegetation guarantees high numbers of the small mammals which form the bulk of their prey, and buzzards are in their ideal habitat.

Chequered history The buzzard has had a chequered history in the British Isles, intimately bound up with its relationship with man. The clearance of woodland by the Middle Ages opened up much suitable country and the bird was certainly common by the 15th century. Thomas Pennant, writing in 1776, regarded it then as the commonest hawk in Britain, although it was already suffering from lack of food because of vermin control. This campaign intensified throughout the 18th, 19th and early 20th centuries, latterly in the name of game preservation. By the First World War the buzzard was very rare; it was absent from lowland England and found only in the more mountainous western areas. With the rapid decline of gamekeeping at the outbreak of World War II the buzzard reoccupied some of its lost ground; and the slightly more enlightened attitudes since that time have enabled the recovery to continue, albeit within limits.

In the mid-1950s myxomatosis, which killed thousands of rabbits, had an instant effect on the buzzard with widespread decreases in breeding reported, especially in southern England. But within only a few years the numbers had readjusted to somewhat lower levels and then stabilised as those individuals which had exploited the plague populations of rabbits in some areas divers-

Common buzzard

Above and below: **Common buzzard** (*Buteo buteo*), 55cm (22in) from beak to tail. Our most common large bird of prey, found in wooded valleys, and on hillsides of western areas of England and Scotland. Small rabbits and other mammals form an important part of the varied diet of buzzards.

Killer poisons

It is well known that in addition to the legal control of some pests, widespread illegal destruction of protected birds and other animals still occurs. The most worrying aspect of much of this illegal killing is the use of poisons on meat baits or injected into eggs and laid in the open. The most common poisons are strychnine, phosdrin and the narcotic drug alphachloralore. They are used to protect game stocks or reduce predation by crows, foxes or lambing flocks, but as they are non-selective, they account for a tragic catalogue of deaths. Apart from target species, buzzards, ravens, magpies, hedgehogs, badgers, farm dogs and other species are regular victims, and, more serious still, rare birds such as the carrion-eating red kite, golden eagle, goshawk, peregrine falcon, marsh harrier and hen harrier. It is not only the range of species that causes concern, but also the actual numbers of birds and mammals killed in one year are horrifying.

ified their feeding. At present the population is probably stable.

Nesting Most buzzards make substantial nests in trees close to the main trunk. They use sticks, twigs and heather, and line the nest with green foliage before laying. Two or three eggs are a normal clutch, although it is unusual for all to be successful. In areas where buzzards are already numerous, one fledgling young is the normal product of a nesting pair. Eggs are laid every few days, and both parents incubate for 33-35 days. The young are on the wing about seven weeks after hatching, so most have left the nest by early July.

Varied diet A large part of the buzzard's success can be attributed to its resourcefulness and catholic choice of prey. Its most important food items are mammals–small rabbits, voles, mice, shrews and others; it also eats amphibians, insects, soil invertebrates, particularly earthworms, and fledgling birds–their immobility makes them relatively easy prey for the slow and somewhat ponderous buzzard.

Buzzards are not agile like kites, sparrowhawks or harriers. They patiently sit on a fence or post, carefully scanning a favoured hunting area to find food which they then take by a straight, silent, planing flight from their perch. They also soar over open ground and can hover well or hang in the wind, kestrel-like. They also spend much time walking around fields, picking up beetles and other large insects, and all kinds of other invertebrates such as earthworms.

The rough-legged buzzard is superficially similar to the common buzzard, but it is only a winter visitor appearing in small numbers, most frequently to the east and north. It is a slightly bulkier bird, with deeper wing beats and a larger, markedly patterned tail. A dark belly patch, rare in the common buzzard, is an aid to identification. Its legs are completely covered with feathers. It is a northern breeding bird, nesting in high latitudes, mainly in open tundra areas, well to the north of the range of common buzzards.

The honey buzzard is also superficially similar to the other two, although it is distinguished by a smaller head and slim neck, and bold barring on the tail and underwings. This is a secretive bird, most at home in a mosaic of mature deciduous woodland and open glades. Honey buzzards winter in wooded country in equatorial Africa, migrating to Europe from early April; some of the crossing points over the Mediterranean are characterised by spectacular concentrations of the birds. A very small breeding population clings to a toehold in southern England where they are carefully protected. The best place to see a honey buzzard is the New Forest.

The birds are largely dependent for food on the nests, larvae and adults of various species of wasps and bees, often found by following the flying insects to their nests. These are dug out with the use of strong feet; the stings are nipped off before the insect is swallowed, and the bird's resistance to stings is enhanced by scale-like feathers on the forehead and lores (the area between the eye and upper mandible).

Above: Buzzard chicks in their nest. The young are cared for by both parents.

Below: The honey buzzard, as its name suggests, is largely dependent on bees, and wasps for food.

LONG-LIVED LICHENS

Lichens, found all over Britain on walls, trees and roofs, are a unique combination of an alga and a fungus. Often destroyed by pollution in towns, they can live for 4000 years in remote Arctic regions.

Of all the living organisms in the natural world, lichens are the only ones in which two completely different 'plants' combine to form a new entity. The organisms involved in this union are an alga and a fungus.

Algae are a large group of plants with primitive features; the simplest members are composed of single green cells, or strings of cells. Typically, these plants form the green scum in ponds or on the glass of an aquarium. Fungi also have primitive features, but they differ from true plants since none of them has ever been known to contain the characteristic green plant pigment chlorophyll. The most familiar fungi are mushrooms and toadstools, but there are many more which consist only of simple filaments (known as mycelia); some of these form the mildews and rusts which affect our garden plants.

Lichens are formed from filamentous fungi and simple algae. The fungus provides the bulk and determines the shape of the lichen thallus (the term given to the body of the lichen) while the algae occurs in a thin layer just beneath the upper fungal 'skin'.

The lichen relationship is often cited as an example of symbiosis, a situation in which both partners appear to benefit mutually from the association. However, some experts believe that in fact the fungus is parasitic on the alga, using the food which the alga manufactures by photosynthesis. Others believe that the alga does benefit from the symbiotic association since it is protected from drought by the fungus, and so can thrive in dry situations which would be unsuitable if it were alone.

Above: *Xanthoria parietina*, a familiar foliose lichen, is found on trees, walls and roofs. Like all lichens it grows very slowly—only 2·5mm ($\frac{1}{10}$in) in a year—and it is badly affected by pollution.

Below: *Cladonia chlorophaea* is a fruticose lichen that grows both on open ground and in woodland, on the base of trees. Because the fruticose branches form little cups, it is sometimes known as a cup lichen.

Widespread habitats Lichens are inconspicuous plants and are generally referred to by their Latin names. Reindeer moss (a species of Cladonia) is one of the few lichens with a common name, which it obtained because it is a fodder plant for reindeer living in Arctic regions. Many lichens are pioneer plants that can tolerate extreme environments such as the Arctic. Yet some of the severest conditions that they experience are in this country on the roofs of houses or on old stone walls in any rural area. Here they form the familiar yellow and grey crusty patches. Lichens have wide variations in colour and form—from vividly coloured encrustations to feathery growths on trees.

One of the best places to see lichens is in damp woodland, particularly in the western parts of Britain where there is a higher rainfall. Although lichens can tolerate dry conditions, they prefer a damp climate. They also prefer a pollution-free atmosphere, and as the west of Britain tends to be less heavily industrialised and therefore less polluted, so lichens flourish more readily there.

Lichens grow in many different places in woodland, such as in the axils of twigs, around the bases of trees or on rotting logs. On the twigs a succession of lichens occurs,

light-tolerant species such as *Usnea* and *Parmelia* appearing towards the tips of twigs, and shade-loving species such as *Buellia* and *Lobaria* towards the centre of the tree. Some lichens are found on particular trees, for example *Usnea* and *Cetraria* favour conifers while *Parmelia*, *Physcia* and *Xanthoria* are found on deciduous hardwoods such as oak or ash. The kind of bark is also important–its alkaline or acid properties, texture and water-holding capacity all play a direct role in the control of lichen growth.

Classification The lichens themselves vary tremendously in form and are classified into three types: crustose, foliose and fruticose. *Pertusaria albescens* is a typical example of a crustose lichen, being so thin and so closely pressed to the bark that it can hardly be separated from the old trees on which it grows. *Lecanora conizaeoides* is another crustose lichen that is of particular interest, for it is one of the few that are resistant to sulphur dioxide pollution in the air. Sulphur dioxide is a by-product of burning coal or oil, and it combines with rainwater to form a sulphurous acid which penetrates and destroys most lichens.

Foliose lichens appear to be composed of many small overlapping leaves. *Parmelia saxatalis* is a common foliose lichen that grows throughout the British Isles, except in upland areas. This lichen also has a common name–crottle–and it was used for hundreds of years as the source of a brown dye used in dyeing wool.

The fruticose lichens are quite distinctive in appearance, being composed of many strap-like or finger-like branches. *Usnea* is a fairly common genus of fruticose lichens, but as it is intolerant of pollution it is only found in the least inhabited areas.

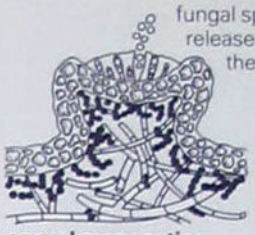
Pollution predictors For many years lichens have been used as pollution indicators. Because lichens do not have roots, they absorb water and gases through their upper protective layer and this makes them sensitive to atmospheric pollution. It is possible to establish the level of air pollution in any one area by checking on the lichen species growing there, and distinct zones can be seen around our major cities. In the innermost zone, centred on the inner city area, no lichens grow at all and this has been called the lichen 'desert'. Around this is the 'struggle zone' where the few pollution tolerant species, such as *Lecanora conizaeoides*, can survive. Moving out into the rural areas, more and more lichens appear, growing more strongly as the pollution levels drop.

It would seem that lichens have a major role to play in modern Britain. They are not only affected by sulphur dioxide, but also by heavy metals such as mercury or lead. Both of these metals are injurious to human health, especially in urban areas. Lichens which absorb the metals become emaciated or die, so an examination of the lichens in an area can indicate whether heavy metal pollution is taking place and the source can then be identified. However, although the Clean Air Acts of the 1950s have helped to protect lichens, they grow extremely slowly and so take a long time to recover from pollution.

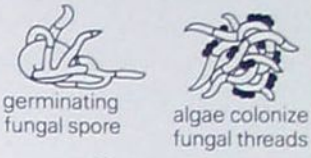
Looking at lichens

The main body of a lichen is made up of enmeshed fungal strands, with an algal layer above and below and a protective outer coating of cellular fungus. Reproduction takes place in two different ways. In vegetative reproduction, fungal threads and algae break off, germinate and disperse together. In sexual reproduction, fungus spores are released to germinate alone, forming a mass of fungal threads which unite with their algal partner.

cross-section of a lichen



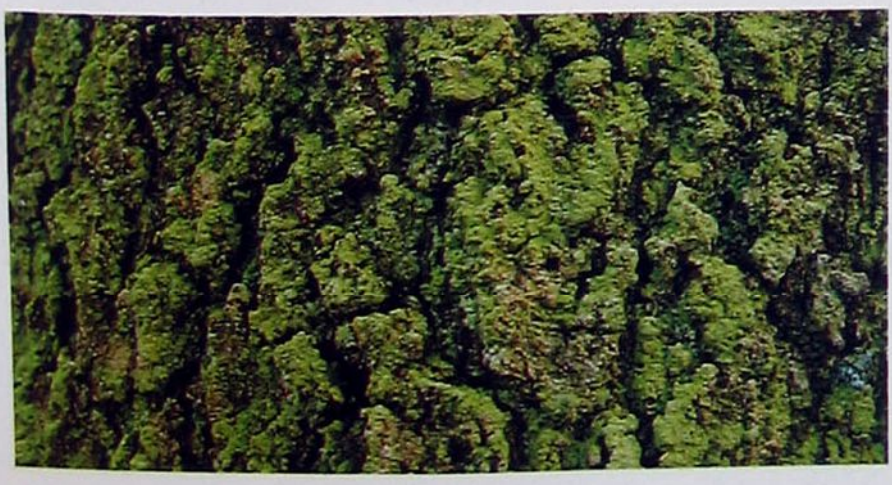
sexual propagation



vegetative propagation
fungal threads and algae released together to start a new colony

Left: *Usnea subfloridans* is a large fruticose lichen found in unpolluted woodland throughout the southern, western and northern areas of the British Isles.

Below: *Lecanora conizaeoides* is a crustose lichen–one of the few that are resistant to pollution. It is found on trees, wooden fences and bricks, where it very often grows in association with a true green alga, *Pleurococcus*. The alga and lichen can be easily distinguished from each other–the lichen appearing as a grey-green powdery growth, while the alga forms a bright green scum.



CANALS: HAVENS FOR WILDLIFE

Britain's 3000 miles of canals – man-made waterways built mostly in the 18th and 19th centuries to carry commercial freight – provide a stable wetland habitat for wildlife.

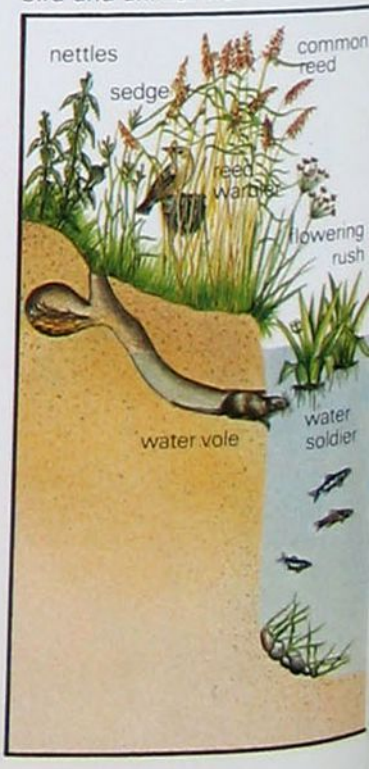
Although the Romans dug Britain's first canal – the Fossdyke – in the second century AD, the great period of artificial waterway construction occurred between the middle of the 18th and the middle of the 19th centuries. These canals, constructed for the carriage of freight between the mining, industrial and commercial centres of the country, linked much of the navigable river system of Britain with a network totalling over 3000 miles in length.

The commercial heyday of the canals was short-lived. The railways took over from the horse-drawn narrow boats and, by the start of the 20th century, canal traffic was declining rapidly and losing its financial viability. As the decline continued many of the smaller branches of the canal network fell into total disuse, but after World War II the greater part of the canal system was included in the programme of nationalisation and came under the control of the Ministry of Transport. In 1962 the British Waterways Board was set up by Act of Parliament to take responsibility for the canals.

Today commercial traffic is almost non-existent, but its place has been taken by a massive upsurge in recreational use – not only allowing the larger canals to be kept open, but also enabling sections of disused ones to be brought back to a working state. If the mileage of canals still in working use is added to that of those which have been abandoned, there is what is virtually a wildlife sanctuary some 3000 miles long.

Canal structure Although a canal may seem to have much in common with a river as far as its wildlife is concerned, there are important structural and physical differences that have considerable bearing on its ecology. In contrast to a river, with its deep, calm pools and rapid-flowing shallows, the variable nature of its bed and a marked fluctuation in water level, a canal is more or less of uniform profile throughout its length. It is deepest in the middle and shelves gradually to shallower margins; there is very little fluctuation in water level, and what is perhaps of greatest consequence to the ecology, there

Above: A stretch of the Grand Union Canal, North Kilworth. This is a tidy, 'managed' canal but its banks and towpath support a wide range of plants – with their associated insect, bird and animal life.



is little flowing movement of the water. A canal is spared the scouring, eroding effect of a river's spate.

The amount of water allowed into a canal is only sufficient to maintain the water level. A controlled flow of water–coming mainly from adjacent rivers or streams–enters the canal at its highest point and flows to its lowest point through a series of locks. This means that noticeable flow occurs only when a lock is opened. The mineral content of the water is influenced to a limited degree by the soil of the retaining banks, while the flowers and plants that grow along the banks are a guide to the alkalinity or otherwise of the soil.

The large surface area of a canal in relation to its depth means that during the long days of summer the water temperature rises considerably, encouraging prolific phytoplankton and algal growth–sometimes to such a degree that the water appears green. The abundance of animal life, from the microscopic zooplankton to the larger insects, crustaceans and molluscs ensures a habitat in which fish can thrive.

Canal ecology There are three ecological zones in a canal: the navigation channel, which is the deepest part, the shallower marginal areas, and the retaining banks. The line of separation between these is not always easy to define: for instance, the marginal shallows zone may be absent, where the banks are reinforced with steel or concrete piling, for example.

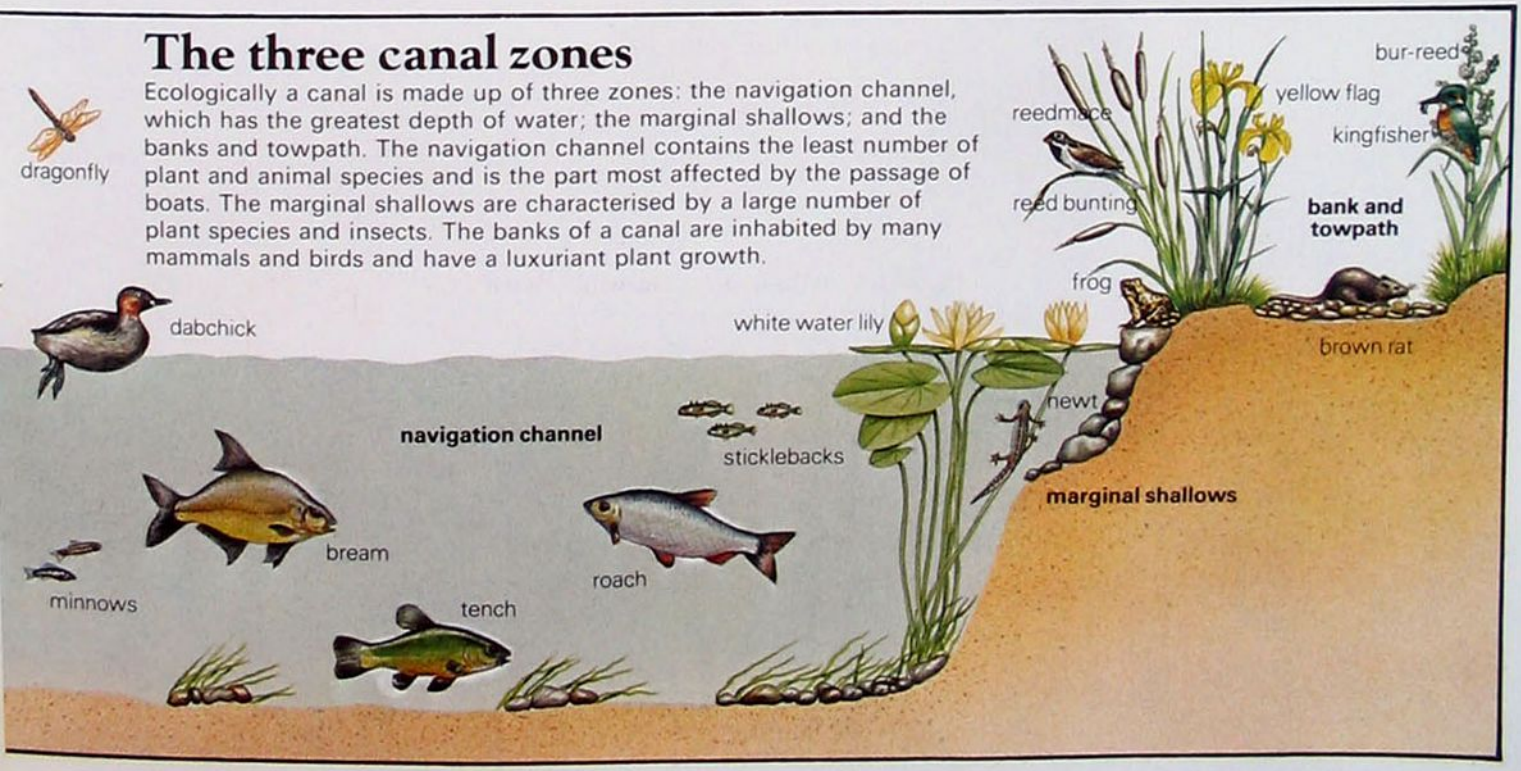
Only a few plants are found in the navigation channel and these are not permitted to develop to an extent where they would hinder navigation. A number of fish occur here, from the rarely-seen, bottom-feeding tench to sizeable bream, carp and roach. The

Above: Part of the old and no longer used Basingstoke Canal, choked with water soldier (*Stratiotes aloides*). As the water level in a disused canal falls, the marginal vegetation extends outwards from the banks and the central channel becomes narrower and shallower. With the changing environment new species become established and in a few decades the waterway is choked with vegetation. The habitat is at its richest at this stage.

Right: Indian balsam (*Impatiens glandulifera*). This, and another species, the orange balsam (*I. capensis*), are both introduced plants that have spread widely along our canal network.

The three canal zones

Ecologically a canal is made up of three zones: the navigation channel, which has the greatest depth of water; the marginal shallows; and the banks and towpath. The navigation channel contains the least number of plant and animal species and is the part most affected by the passage of boats. The marginal shallows are characterised by a large number of plant species and insects. The banks of a canal are inhabited by many mammals and birds and have a luxuriant plant growth.



Lancaster canal, in particular, has an astonishing variety of fish species.

A large number of plant species grows in the marginal shallows zone. Floating plants include the duckweeds (*Lemna* species), while pondweeds such as *Potamogeton crispus* have totally submerged foliage.

Undoubtedly the most abundant flora of the shallows are the emergent plants, with foliage above the surface. These plants provide cover for nesting birds that find seclusion and relative safety among the luxuriant growth of bur-reed, reedmace and common reed.

In this area of shallow water several less common plants occur. Perhaps the loveliest of them all is the flowering rush, a plant characteristic of our canal margins. Among several introduced plants well-established as members of the waterway environment is the curious-looking sweet flag, a plant not often noticed when its strange spike of greenish flowers is not in bloom. A more recent introduction is the orange balsam or jewel-weed (*Impatiens capensis*), but this has spread so widely along our canal network that it can be regarded as the plant most typical of the canal habitat.

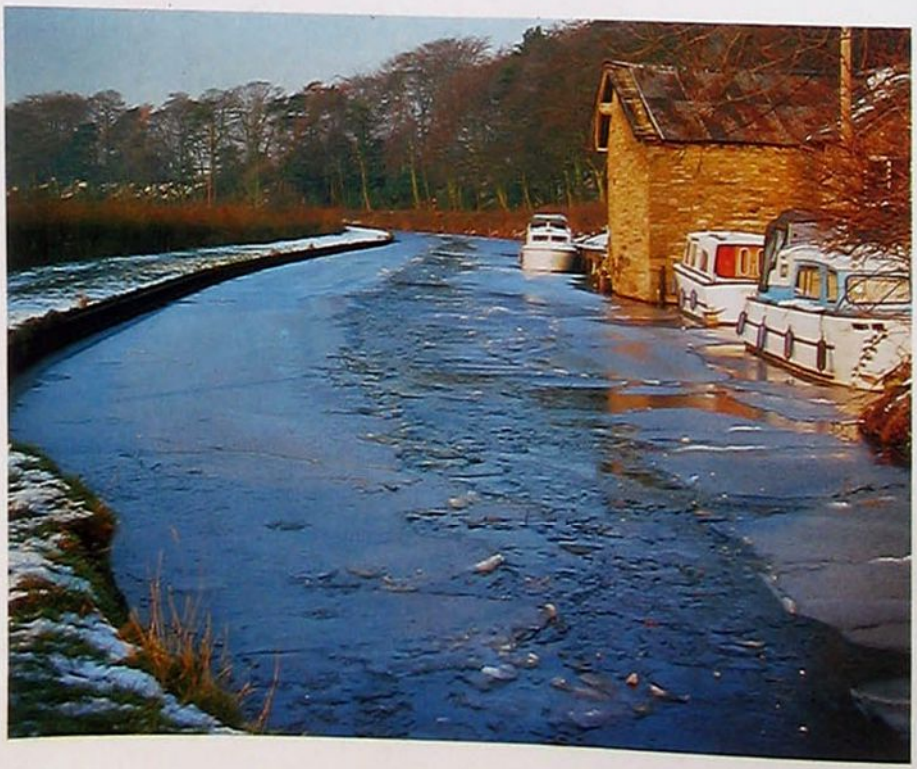
Many of the insects of the waterways can be found among the vegetation of the shallows. Dragonfly nymphs are not easy to see, but the adult dragonflies attract attention by their size, dashing flight and gaudy colours. Canals are particularly good habitats for aquatic snails; the steady water flow brings a regular supply of nutrients, there are no sudden catastrophes such as floods which could sweep the snails away, and the temperature is generally warm.

High banks are not often seen in canals, but where they occur they are often riddled with holes made by the water vole, perhaps the most characteristic canal-side mammal. A less welcome mammal is the brown rat that lives in holes in the banks or under a hedge.

Where a luxuriant growth of marginal plants merges with grasses, willowherb, brambles, sedges, nettles, sallows and hawthorn the ecology starts to resemble that of a scrub-covered hillside with, in season, breeding birds such as the whitethroat and lesser whitethroat, yellowhammer and linnet, together with the two most typical birds of the canal-side, the reed bunting and the sedge warbler.

Above: Where a canal towpath is no longer in constant use, and under wear from the feet of walkers and anglers, plants such as the stately yellow flag (*Iris pseudacorus*) can become established.

Below: Peak Forest Canal at Lyme Green, Macclesfield. A period of prolonged and severe frost has covered the canal with a sheet of ice. When a canal ices over like this, birds such as coots and moorhens which are dependant on open water, must move elsewhere, but the ice has little effect otherwise on life in the canal.



Maintaining a working canal The changes that occur in a working canal are slight. The ecological balance is maintained by the very fact that the canal is being used. Navigation channels must be kept open, banks maintained in sound condition, depth kept constant by periodic dredging and random seedlings of trees and shrubs cut to ensure that the towpath does not become an impenetrable forest. Therefore a walk along a canal today is likely to produce the same bird species, mammals and flowers that you would have seen a century ago. The only things missing are the horse-drawn boats.

Disused canals In a canal where use and management ceased long ago, a fascinating type of wetland habitat has the chance to develop. The water level is no longer maintained and falls slowly, the vegetation growing at the margins spreads out from the banks, the central navigation channel becomes shallower and narrower, and new plant species start to gain a foothold. Uncommon plants such as frog-bit and water soldier may occur in great profusion, with great patches of yellow loosestrife on the canal banks.

Yet, the profusion of wildlife is just a transitional phase. Left to itself, the disused canal transforms completely. Decaying plant debris gradually replaces the water as species such as the common reed extend their dominance, trees such as willows, poplars and alders become established and the true aquatic plants and the insects associated with them disappear. There is eventually little to remind you that this was once a busy working waterway.